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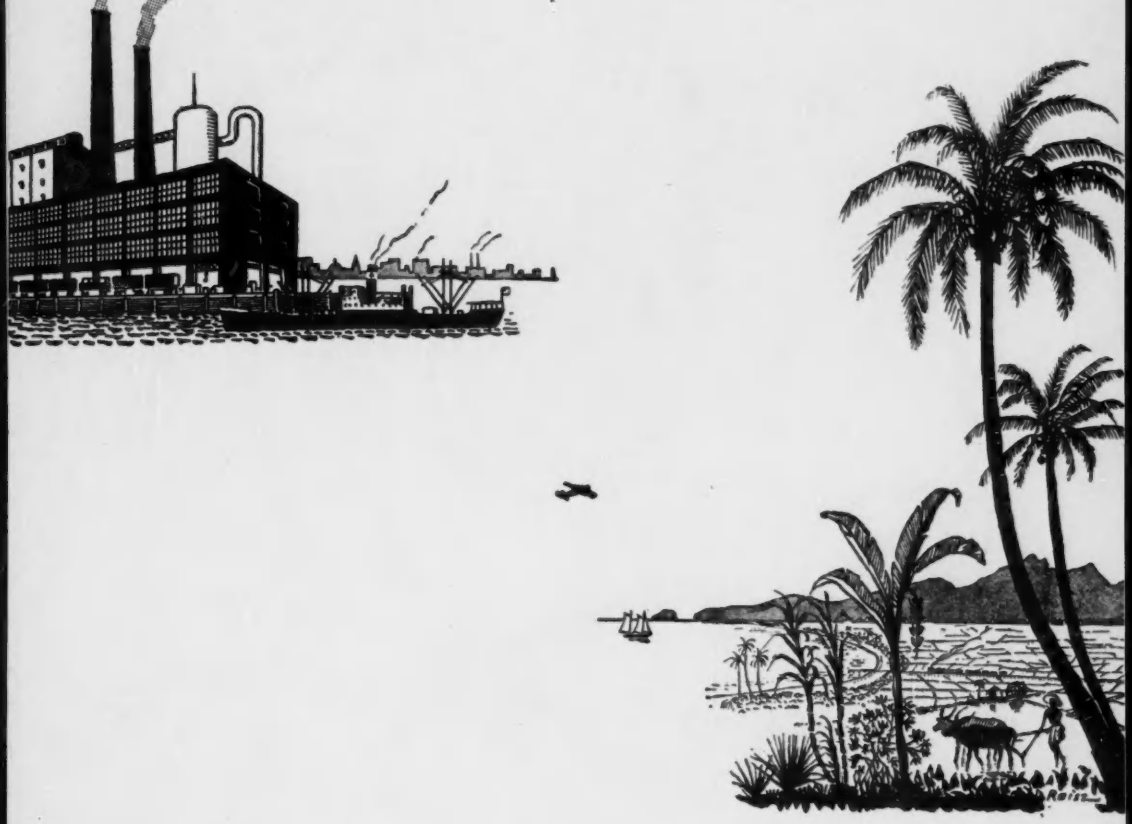
ECONOMIC GEOGRAPHY



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ECONOMIC GEOGRAPHY

VOL. 35 APRIL, 1959 No. 2

STUDIES OF SEMI-NOMADISM IN NORTH AFRICA

John I. Clarke

Dr. Clarke is a Lecturer in Geography in the Durham Colleges of the University of Durham. His paper is a product of several field seasons in North Africa.

CLASSIFICATIONS are basic in our teaching of geography. They are more or less logical simplifications to facilitate our understanding of the range and diversity of physical and human phenomena, and among the more common classifications to appear in our textbooks are those of rocks, strata, landforms, streams, climates, soils, vegetation, races, cultures, settlements, economies, and modes of life. Some classifications are spatial, some are divisions of time and some are both, but none are comprehensive. Thus, only a few elements may be used in a classification of climates, only a few factors of pedogenesis in a classification of soils, and in a classification of towns it is almost impossible to consider all the relevant features or factors in their evolution. Similarly, the migrations of pastoral nomads have been classified according to distances covered, periodicity, duration of departure, location, and type of livestock, as well as by combinations of these aspects. Which is the most satisfactory? Obviously classifications are intrinsically arbitrary.

It is evident, moreover, that classifications of mankind are inevitably less satisfactory than those of factors in the physical environment because man is so dynamic. His mobility, adaptability, reasoning, and procreative powers have meant constant changes in his numbers, distribution, and social, economic, and political activities; and consequently human classifications, distributional or historical, have none of the apparent rigidity of those of the environment.

Sometimes, therefore, it is not fully realized that a division of primitive economies into a few broad types, such as hunting and collecting, pastoral nomadism, and sedentary cultivation, masks many intermediate stages. Many modes of life do not fall into any of these categories because they involve varied activities. Some reflect a transition between two types, although one should be beware of the idea of a hierarchy of economic evolution, each step being necessary to all groups.

SEMI-NOMADISM

Despite the common concept of the clash between the desert and the sown, of the social, economic, and political systems of the pastoral nomad and the cultivator, there are, of course, any number of communities whose modes of life involve different proportions of pastoral nomadism and cultivation. They are often engulfed in the term

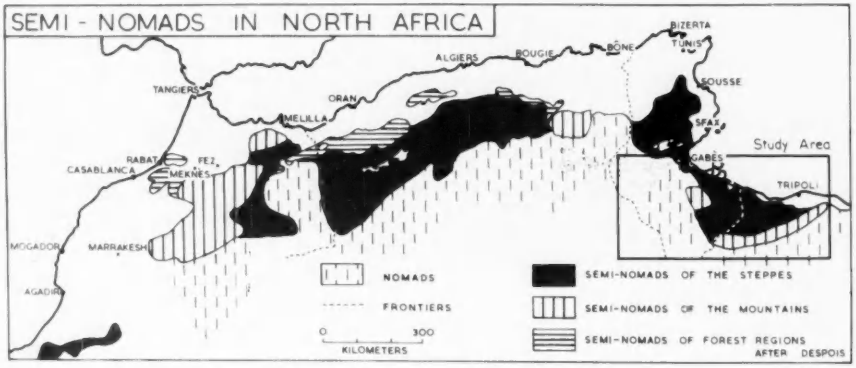

FIG. 1. The semi-nomads of North Africa occupy an irregular steppe or semi-desert zone between the Mediterranean littoral and the Sahara.

semi-nomadism, which usually implies some cultivation and a fixed abode for part of the year, although there is no unanimity about the duration of the latter. Some, especially French geographers,[1] call this a semi-sedentary mode of life and confine the term semi-nomadic to those tribal groups whose migrations are limited by the majority of sheep over camels, a feature typical of many semi-desert regions. This subtle distinction seems hardly justifiable for the number of tribes which are either semi-sedentary or semi-nomadic is so much smaller than the number which are both.

Semi-nomadism may be found in true deserts but this mixed mode of life is most typical of the desert peripheries, of the broad transitional zones of semi-desert and steppe where rainfall unreliability provokes great fluctuations in crop yields, unless irrigation is possible. In other words, geographical conditions favor a double existence especially when lack of capital and specialized techniques make large-scale cultivation difficult. But the exact nature of the mode of life of a particular tribal group depends on many other human factors such as the size of the group, its traditions, its neighbors, and the wealth, attitude, and stability of the central government. This last point must be stressed, because in semi-desert regions, where the environment is largely unfavorable for agriculture and the ecological balance is delicate, agricultural prosperity may be permanently endangered by political instability. Small wonder, therefore, that desert fringes are zones of flux, where immense economic and social changes occur. They are zones of contact, stimulus, and sedentarization.

[1] For example, P. Birot, and J. Dresch: *La Méditerranée et le Moyen Orient, Tome II, La Méditerranée Orientale et le Moyen Orient*, Paris, 1956, p. 310.

STUDY AREA

In North Africa we find such a zone to the interior of the moister, more-developed Atlantic and Mediterranean domains, extending into northwestern Tripolitania and then recurring on the eastern side of the Gulf of Sirte in northern Cyrenaica. Everywhere the backwardness of this zone contrasts markedly with the colonial agriculture and urban growth of the maritime belt. Despois[2] distinguishes in this zone three main types of semi-nomads according to the regions inhabited: semi-nomads

[2] J. Despois: *L'Afrique du Nord*, Paris, 1949.

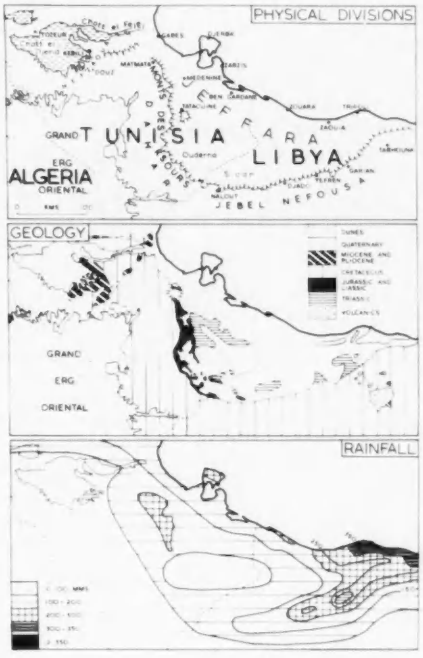

FIG. 2. Study area of southern Tunisia and northern Tripolitania.

of the steppes, of the mountains, and of the forest regions (Fig. 1).

One sector of some physical and human diversity lies astride the Tunisian-Libyan frontier south of the Gulf of Gabès and the salt-crusted mud flats of the Chott el Djerid and east of the vast sand sea of the Grand Erg Oriental (Fig. 2). It contains three physical units:

(a) The *Jeffara* (Fr.) or *Gefara* (It.), a bare boomerang-shaped coastal plain, 250 miles long, pocketed in places by saline depressions and sprinkled generously with sand and gravel which do not always obscure underlying Triassic rocks. It is the main routeway into the Maghreb from the east, once used by invading Arab tribes and more recently by the armies of Rommel and Montgomery. Apart from a few isolated exceptions, cultivation is restricted on the one hand to a narrow coastal margin where humidity is comparatively high and rainfall everywhere over 150 mms. (c. 6 ins.) and on the other to intermittent small oases along the spring line at the foot of the southern escarpment. The most extensive area of cultivation is on the narrow, moister eastern Jeffara south and east of Tripoli, the scene of dense Italian colonization.

(b) The plain has been formed by the erosional retreat of the *Jebel*, a remarkably regular arcuate escarpment of Jurassic and Cretaceous limestones and marls, and with many local names. Twelve hundred to 2000 feet high, once a refuge for Berber tribes and now a conservatory of their customs, it benefits from slightly higher rainfall than the Jeffara, especially as its two extremities, the Matmata in the west and the Jebels Garian and Tarhouna in the east. Here sedentary cultivation has long been practiced, whereas in the center the Jebalia, or mountain dwellers, are more nomadic. The long, gentle dip-slope, the *Dahar* (Tun.) or the *Gibla* (Trip.), is wadi-scarred and gravel-strewn, and much too dry for cultivation, although on the eastern "shores" of the Chott el Djerid, in the Nefzaoua, numerous small oases bear witness to the local artesian basin.

(c) The dip-slope shelves under the *Grand Erg Oriental*.

Here in southern Tunisia and northern Tripolitania we find a

FIG. 3 (left). Looking northwards across the Jeffara from Giosc.
FIG. 4 (right). The scarp of the Jebel Nefousa.

whole gamut of tribes from the completely sedentary to the completely nomadic,[3] from the pure Arab to the pure Berber, and few tribes have identical modes of life. We have only space to examine four brief case studies, those of the Gherib, Merazigues, Ouderna, and Siaan, the first two being tribes of the Nefzaoua, and the last two adjacent tribes of the central Jeffara. All are found in areas with less than 6 inches of rainfall per year.

THE GHERIB

The Gherib are a small tribe of 1300–1400 people of Berber stock who live in the driest corner of Tunisia and who felt little of the impact of French civilization on their country. They are perhaps more nomadic and more rustic than any other tribe in Tunisia, although, of course, Tunisia has no "grands nomades." They are all remarkably alike—alert, short, gnarled, and with skins like leather—speak a crude form of Arabic, practice more animistic rites than orthodox Islamic observances, and consequently they are scorned by their neighbors in the Nefzaoua.[4] Like the Sabria, a neighboring tribe to whom the Gherib are related and whose way of life is very similar, they are maraboutic (descended from a holy man), and before the French occupation in the 1880's they profited from this by asking for alms in times of distress, by obtaining extensive pasture rights, and also by avoiding payment of tribute to other more powerful nomadic tribes. But by raids in the nineteenth century on the important oasis of Ghadames, just beyond the southern tip of Tunisia, they and the Merazigues incurred the wrath and vengeance of the Touareg Ifoghas and the Haouamed of Tripolitania and were severely defeated by them. The Gherib lost most of their stock and have never fully recovered. They are now poor, have few tents, and often sleep in their burnous in the open air or under their tiny brushwood shelters or "zeribas" (Fig. 5), living almost entirely on camels' milk, dates, and a little barley meal and olive oil.

Today with their camels and goats they wander in search of pastures over the barren wastes south of the Chott el Djerid (Fig. 6), from time to time going as far as Bir Romane, but this well is frequented more by the Rebaïa and

[3] For tribal structure see: *Nomenclature et répartition des tribus de Tunisie*, Chalon-sur-Saône, 1900; E. de Agostini: *Le popolazioni della Tripolitania*, Tripoli, 1917.

[4] See P. Moreau: *Des lacs de sel aux chaos de sable. Le pays des Nefzaouas*, Tunis, 1947.

FIG. 5. A Gheribi sitting by his brushwood bivouac, or "zeriba." (Photo: J. L. Combès.)

Troud of Algeria who also often penetrate eastwards to Bir Aouine. The Gherib have stores for grain and dates at Zarcine and Sabria, but they rarely stay there longer than a few weeks in October or November. In recent years, however, artesian wells have been bored at El Faouar, at the southwestern extremity of the crescent of oases, and about 100 acres are now irrigated. So some settlement is taking place. The process has just started and it is not proving easy, for the Gherib, the purest of the Tunisian nomads, have no traditions of cultivation.

THE MERAZIGUES

The Merazigues, who number about 7250, are also maraboutic and born beggars. At one time they used to hire or borrow camels for trading between Gabès on the coast and the oases of Ghadames, the Fezzan, and the Oued Souf in Algeria. Based on Douz, which in 1882 contained only one mosque, two oratories and four hovels, they were much more nomadic than they are today and spent just one or two months at the oasis for the date harvest. Moreover, the tribe was a unit, which departed "en masse" for the summer pastures, and although its three fractions, the Douz Chergui, Douz Gharbi, and El Aouina, subsequently went their own ways, they all contrived to return together during the first half of October. In times of spring drought the Merazigues would join forces with the Sabria and Adhara to form large caravans six or seven hundred strong with three or four hundred camels for the migration northwards to the richer pastures of the Tell.[5]

Now trading caravans have greatly diminished and collective migrations have disappeared; each family organizes its own movements. Moreover, the three fractions, which are of similar size, seem to be breaking away from each other; different cultivation patches

[5] J. I. Clarke: "Summer nomadism in Tunisia," *Econ. Geogr.*, Vol. 31, 1955, pp. 157–167.

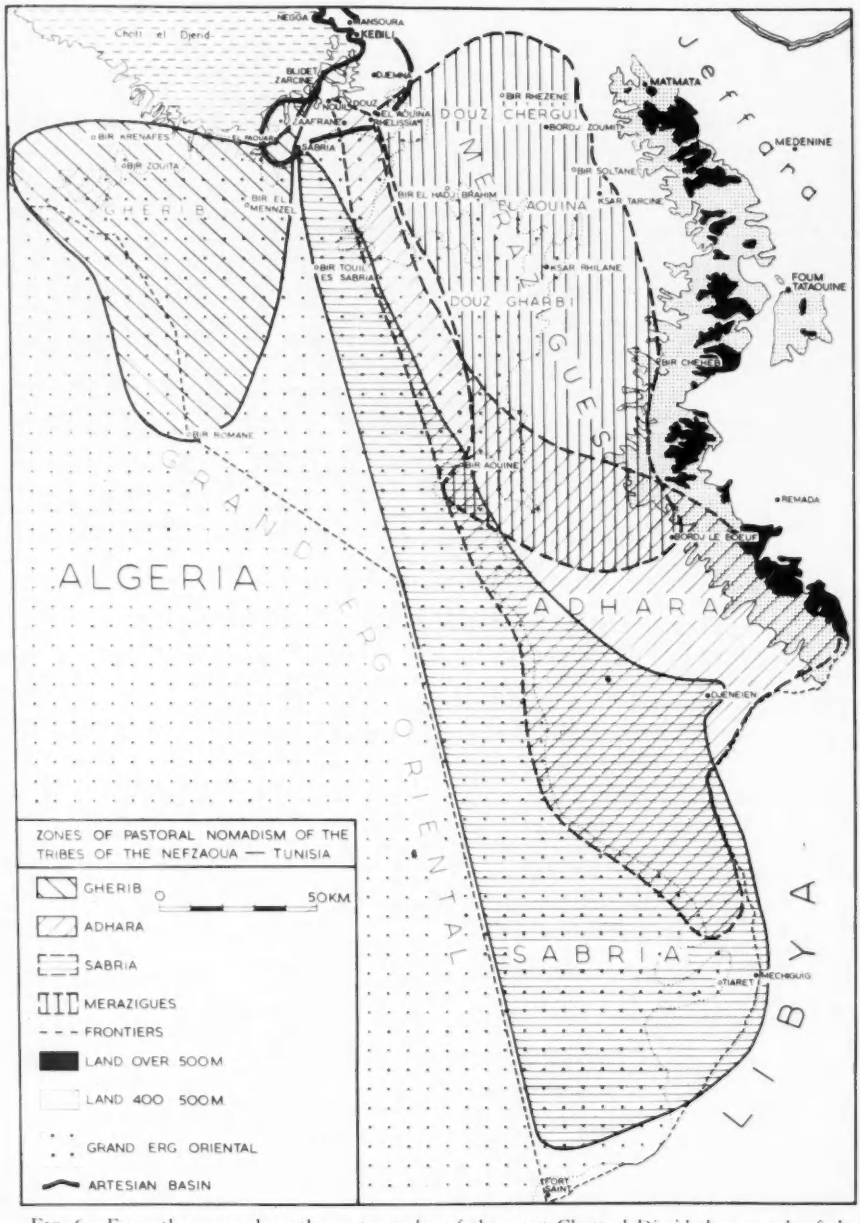

FIG. 6. From the oases along the eastern edge of the great Chott el Djerid the nomads of the Nefzaoua migrate southward across the gravel dip-slope of the Dahar or the dunes of the Grand Erg Oriental.

FIG. 7. Douz, southern Tunisia. (Photo: J. L. Combès.)

—moister hollows and wadis where cereals are grown—and different pasture zones on the Dahar demonstrate this trend, although these zones are far from rigid. And now the El Aouina have their own village on the eastern side of the main settlement, Douz, which has now more than 500 buildings with two distinct quarters for the Douz Chergui and Douz Gharbi (Figs. 7 and 8). Now these are only deserted in spring. The return to the oasis in summer is also a sure sign of the decline of nomadism, a process greatly facilitated by increased artesian water supplies since the last war. This water can be used more profitably by cultivating trees, date palms usually, than by creating forage and pasture reserves, despite the need for these reserves if pastoralism is to remain viable. Care of date palms and the harvest have often forcibly restricted migrations, although not always, for many nomads employ cultivators to tend to their trees. Unfortunately, cultivation is still degrading to the noble nomad, and many notables have disdained to exploit their own lands, but employ "Khammes" or share-croppers, who are often negroes, the descendants of slaves. Stock are still important, but fluctuations in their number with the whims of rainfall have shown many Merazigues the benefit of a reliable revenue. They have not forgotten the terrible drought of 1943–48 when their herds and flocks were decimated and they themselves were in a dreadful plight.

FIG. 8. The souk or market of the Merazigues at Douz.

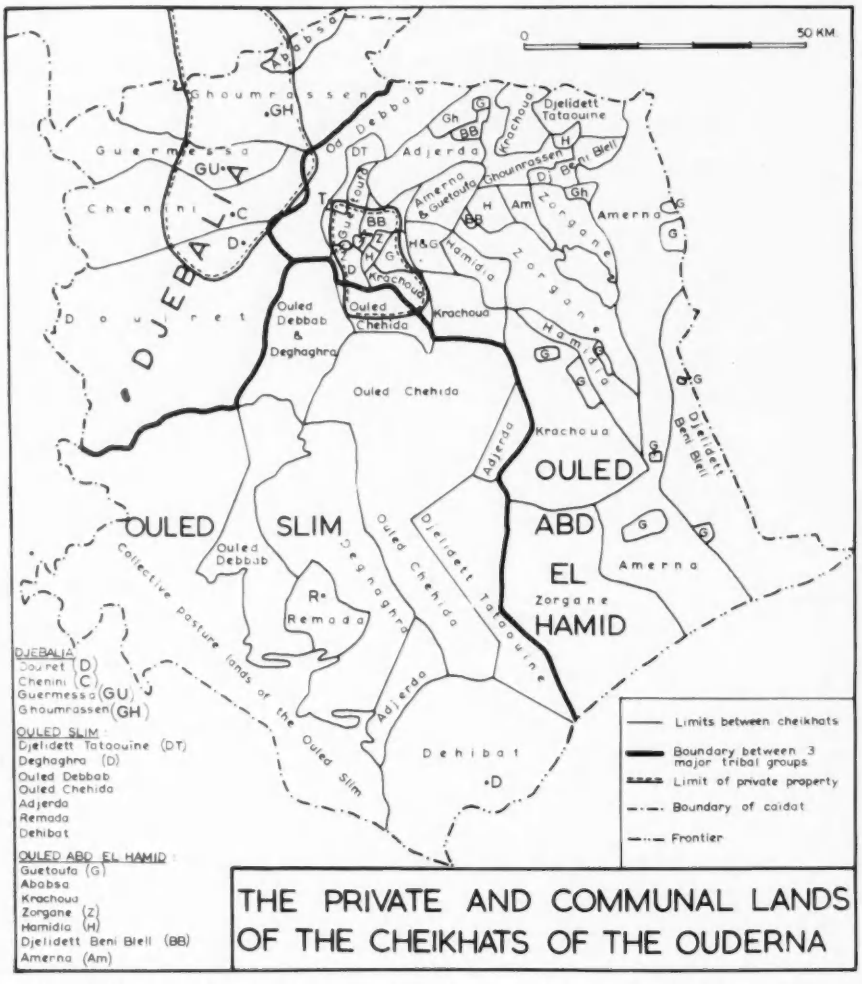

FIG. 9. The acquisition of private property in the Jebel and the division of tribal territories has facilitated sedentarization of nomads.

Many of the problems in the passage from a nomadic to a sedentary existence are gradually being resolved, but it seems that a balance of pastoralism and agriculture will be necessary because of limited water resources. The artesian basin of the Nefzaoua is not inexhaustible, and the limits of its supply appear to have been reached.

THE OUDERNA

The lands of the Ouderna are on the driest part of the Jeffara. They are overlooked by the high escarpment of the Monts des Ksours, inhabited by the *Jebalia*, more sedentary, often cave-dwelling Berber people whose presence has influenced so much the ways of life of the surrounding nomadic tribes. The

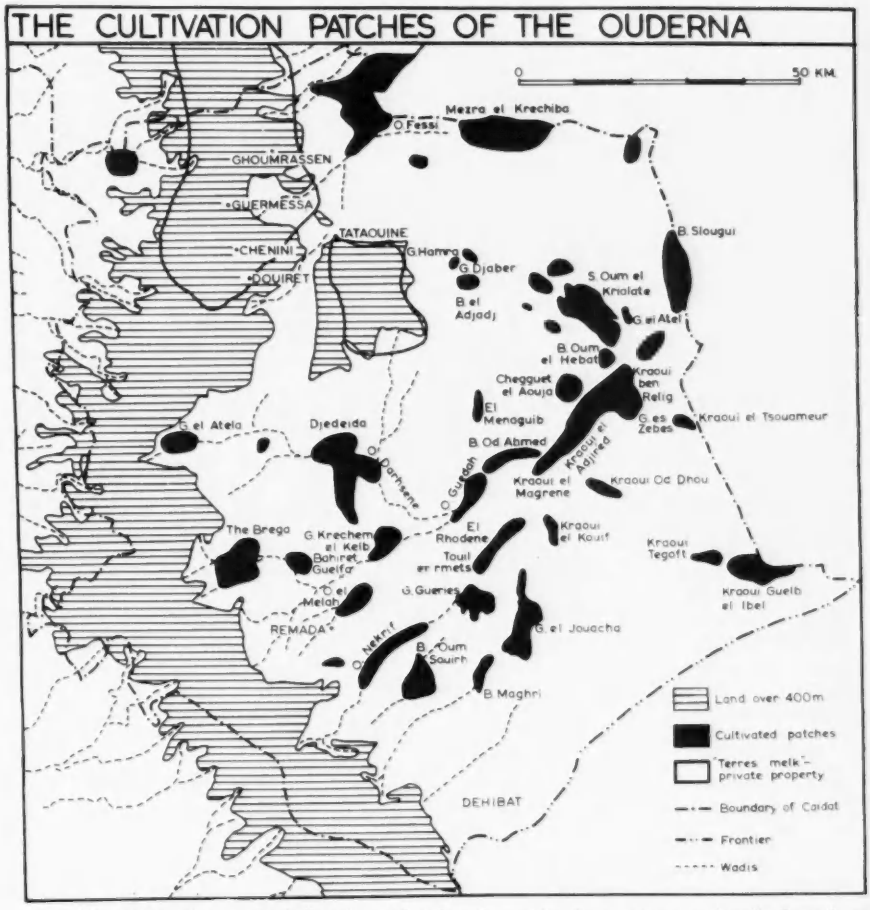

FIG. 10. Cultivation on the Jeffara is restricted to the wadis where water occasionally flows from the Jebel, and to the moister hollows or "kraoui."

Jebalia have a long tradition of cultivation along the wadis of the Jebel, cultivation which is more profitable than in former times since they no longer endure forcible and onerous "protection" by neighboring nomadic tribes. In these associations the Ouderna were particularly apt and their punitive expeditions to extract dues were always severe and efficacious. This subjection of the cultivator to the nomad officially disappeared three-quarters of a century ago, but the different mentalities remain: the Jebali works harder, perseveres more and plans for the future; the nomad is more noble, hospitable, and fatalistic, but poorer.

The Ouderna, who today number nearly 42,000, are one of the main tribal groups belonging to the great confederation of the Ouerghemma which once controlled all the frontier region of southeastern Tunisia. It contains two groups itself, the Ouled Slim and the Ouled Abd el Hamid, each with seven cheikhats (Fig. 9) of which those sta-

FIG. 11. The interior of the "ksar" or fortified granary of Krachoua, one of the cheikhats of the Ouderna. The sheikh, two notables, and a policeman pose in front of the tiered "ghorfas" or vaulted rooms.

tioned early in the region, like the Djelidett Tataouine, Deghaghra, Guetoufa, and Ababsa, lost their warlike-character and started to cultivate.

Deprived of dues from the Jebalia, many of the Ouderna have to rely entirely on their flocks, a small amount of cereals, and a few trees. At the end of the great drought of the 1940's it was estimated that nine-tenths of the livestock of the Ouderna had perished. This certainly accelerated sedentarization, but drought does not affect all alike. Several rich folk sold their stores of grain at high prices, while many of the poor became poorer and the number living on charity in the villages increased, especially in Tataouine. Others ventured into northern Tunisia to seek work on farms or in the towns.

In contrast to the cheikhats of the Jebalia, which are similar to strip parishes extending from the Jeffara over the Jebel on to the Dahar, the cheikhats of the Ouderna are fragmented and far from homogeneous (Fig. 9). Most have three distinct sectors. Firstly, there is the privately-owned land, or "melk," in the Jebel Abiodh, a low outlier where trees are grown around the "ksours" or fortified granaries (Fig. 11). Here the lands of the different cheikhats often overlap. Then at the foot of the Jebel there is a zone a few miles wide which is legally communal land but is worked on a family basis, and is the scene of increasing plantations of olive and fig trees and date palms by semi-nomadic peoples seeking a supplementary source of livelihood. The third sector is down on the Jeffara, where pasture lands and cultivation patches occur (Fig. 10). Pasture lands were divided more equitably by the French during the years 1906–10, but their limits have been defined only since 1918, when the cheikhats were allowed to acquire certain lands irrevocably. This delimitation of territory has undoubtedly fostered tribal disunity and facilitated settlement, although it has also tended to perpetuate small-scale migrations.

Towards the end of October, when temperatures are lower and the figs and many of the dates have been gathered, tents are loaded on camels and then many families slowly move their flocks of sheep and herds of goats towards the communal grazing lands. This is not a general exodus for some may not depart until the end of the date harvest or even the olive harvest which occurs at the end of the year, while others may leave at the end of October and return specially for the olive harvest in December. Immediately rain falls on the Jeffara there is a

FIG. 12 (left). The tomb of a marabout at Giosc. The Jebel Nefousa can be seen eight miles away.

FIG. 13 (right). Part of the oasis of Giosc es Seghir. The palm-frond hut in the foreground is known as a "khus."

rush to the moister basins which form the best cultivation patches. The first-comer chooses the best land, and all the family take part in the plowing so that they can go quickly to another good piece of land before anyone else arrives. Sometimes violent disputes occur. Plowing and sowing over, the families hurry to the pastures which are now green again so that flocks can fatten and fortify themselves for the approaching dry season. In spring everyone is down on the Jeffara and the villages of the Jebel are deserted. It is the blessed season; it is mild, there is plenty of milk, and work is rare, for the men at least because women perform all the menial tasks. By the end of April milk becomes more scarce, so the flocks are left in the hands of herdsmen while the wheat and barley is harvested—if there is any to harvest, for the yield is as uncertain as anywhere else in the south. It is trodden and winnowed on the spot, and camels take the grain and straw to the "ksours" or to underground silos. There the families settle down temporarily, living usually in quickly constructed huts of palm fronds (as in Fig. 13), cooler than black tents. The fig gathering commences in July and all hands are needed for this pleasant task.

So the nomads of the Ouderna live under the tent for eight to ten months each year, and spend the other two to four months in temporary huts, cave-dwellings, or "ksours." The migrations are not extensive, as sometimes the tents may remain seven or eight months in the same locality. This annual cycle, however, is idealized, and there are numerous exceptions among the many fractions of the cheikhats. The Brikat fraction of the Dehibat, for example, have long possessed property in the Jebel Matmata at the northern end of the escarpment, where they cultivate olives, figs, and dates, visiting their trees every summer but taking their flocks only in lean years. The other fractions of the Dehibat and the people of the small cheikhat of Remada usually spend their summers working for the government, mending roads and cisterns. The economy of many of the Guetoufa, Deghaghra, and Djelidett Tataouine is approaching that of the Jebalia, and even the Ouled Chehida, once powerful warriors, show strong tendencies in this direction. Increasing cultivation of trees is modifying the modes of life of more and more, especially among the Ouled Slim, whose lands are generally closer to the Jebel than those of the Ouled Abd el Hamid.

Sedentarization of the nomads, which is stronger than in the Nefzaoua, has had several noteworthy results:

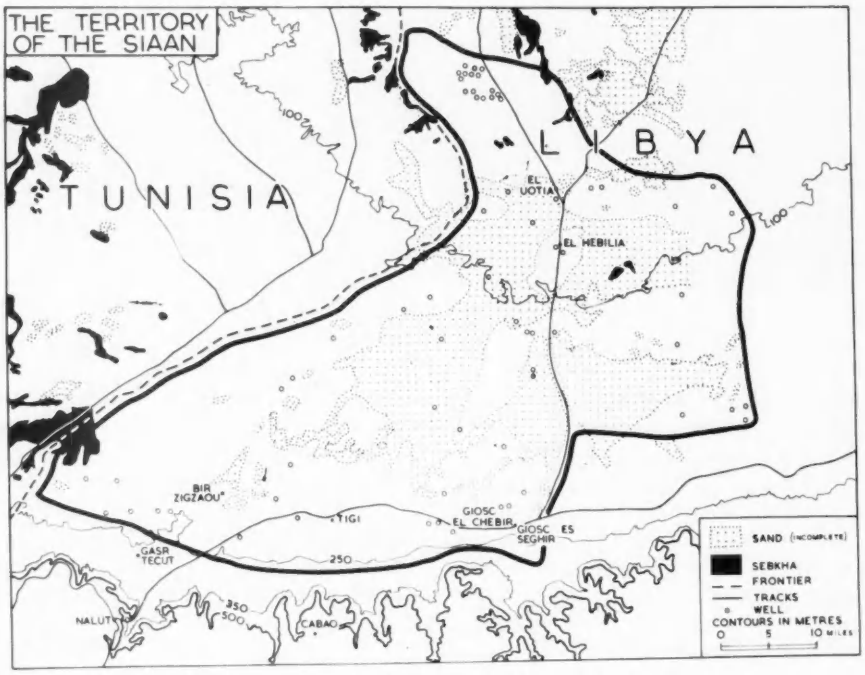

FIG. 14. The bare, gently sloping plain here offers few possibilities for cultivation.

(a) The more settled groups are employing a growing number of herdsmen from the less settled groups. This trend has occurred only in the past 25–30 years.[6]

(b) The increasing incidence of summer nomadism in recent years is a reflection of the poverty of the nomads. The main movement is towards the olive plantations of Gabès, Zarzis, and the island of Djerba for the harvest. Transhumance towards the Tell only takes place when it is necessitated by prolonged drought, and then many prefer to sell their animals on the spot rather than set off on the long journey northwards, which has so many hazards: the scarcity of pastures and their high prices, the high mortality among the animals, and also the annoying administrative formalities.

(c) Temporary emigration to the towns and villages of the north is a feature of the more settled groups.[7] Nomads are endeavoring to emulate the more specialized and more rewarding emigration of the Jebalia.

(d) Cave-dwellings and "ksours" are used by a growing proportion of the population.

There has been, therefore, considerable evolution in the mode of life of the Ouderna, but their standard of living

[6] See M. Galopin: "Le Contrat d'Elevage dans le Sud Tunisien," *Inst. des Belles Lettres Arabes*, Tunis, Vol. 12, 1949, pp. 167–172.

[7] See J. I. Clarke: "Emigration from Southern Tunisia," *Geography*, Vol. 42, 1957, pp. 96–104.

is still much lower than that of the Jebalia, whose revenues are much higher and more stable. The nomads eat less—they lack above all fresh vegetables and eggs, suffer more from disease, and remain totally uneducated.

THE SIAAN

Over the frontier in western Tripolitania are the Siaan, a neighboring Arab maraboutic tribe (Fig. 12) of over 7500 people, of which no more than one in thirteen is sedentary. This small minority inhabit a few tiny oases along a fairly continuous spring line some miles north of the unbroken barrier of the Jebel (Fig. 14). The principal ones are Giosc es Seghir (Fig. 13), Giosc el Chebir, Tigi, and Bir Zigzaou, where squalid housing, poor palm groves, and poverty indicate the subsistence nature of agriculture. Too many varieties of poor quality date palms are grown and too many trees bear ugly scars due to the extraction of lagbi, or palm-wine. No dates are exported. Giosc es Seghir and Tigi are the two administrative villages, centers of mudirea, and both have a weekly souk or market.

The majority of the Siaan are semi-nomads who migrate over the two thousand square miles of gravel and drifting sand which comprise the tribal territory, but their lives differ from those of their neighbors, the Ouderna, in several important ways. Firstly the six cabilas or tribal units of the Siaan—the Ouled Sharadah, Ouled Mohamid, Ouled Sellam, El Hemaila, Ouled Hamid, and Ouled Talab (non-maraboutic)—possess no territory, private or otherwise, in the Jebel and very little in the oases. Very few, therefore, have permanent dwellings. In summer, most pack up their black tents and construct cooler palm frond huts or "khus" which are often set up near the oases. Furthermore, the Italian administration of the inter-war years made no division of the tribal territory in favor of the various cabilas. The latter traditionally frequent certain areas but these are not defined or delimited, and the cultivation patches, mostly in the slightly moister southern part of the territory, are annually redistributed to family heads according to the availability of rainfall. Consequently, the Siaan have not suffered from gradual disintegration, and there is little emigration of any kind, although it must be said that in Tripolitania only Tripoli itself exerts a major urban attraction.

Tripolitania has no equivalent of the Tell of northern Tunisia and so there is no real escape in time of drought. Thus livestock numbers vary greatly; in 1957 the Siaan had over 6000 camels, over 6000 sheep and over 18,500 goats. However, the coastal zone west of Tripoli has many fine date plantations which provide work for some at harvest time. Nevertheless, like several of their neighbors the Siaan feel constrained to engage in profitable contraband, which they perform most efficiently over the long desolate frontier. It provides in some cases the only reliable source of income!

CONCLUSION

These tribal studies could profitably be multiplied to demonstrate the subtle differences between tribal units, as well as the dangers of generalization. It is no easier to generalize about semi-nomadism than about any other human activity. But the following points should be noted:

(a) Semi-nomadism is not determined by physical conditions alone; human factors, have greatly influenced the extent of the nomad's domain.

(b) Semi-nomadism is not inevitably a social and economic advance

over pure nomadism. Many semi-nomads have been failures as nomads and are very poor, but many cultivators and village-dwellers are poorer. On the other hand, nomadism in any form does not permit cultural advance in the same way as a sedentary existence. It is very difficult, for example, to establish a nomadic school.

(c) Semi-nomadism is not a necessary transitional phase between nomadism and agriculture; it is a distinct mode of life.

(d) Semi-nomads may be officially settled more easily than nomads, and in many countries, particularly the U.S.S.R., they are fast on the wane. Semi-nomadism is essentially subsistence economy, and in many areas it needs little imagination to prognosticate its replacement by extensive forms of agriculture. The Italians in Libya were interested only in colonization, but in Tunisia, the French planned to eliminate semi-nomadism by "fixation au sol," which meant settlement through arboriculture. This policy met with varied success due to the diverse difficulties of water supply, soils, land tenure, and the attitude of the nomads.[8] The main needs are money and water, but the former may not provide the latter. Now that Tunisia and Libya are completely free from foreign rule, it will be interesting to see how they tackle the problem.

[8] *See* A. Bessis, P. Marthelot, H. de Montety, D. Pauphilet: "Le Territoire des Ouled Sidi Ali Ben Aoun," Paris, 1956.

TIN MINING ON THE JOS PLATEAU OF NIGERIA

B. W. Hodder

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THE mining of tin has been largely responsible for profound changes in the landscape and in the social and economic structure of the Jos Plateau over the last 50 years. At the beginning of the present century, the plateau was one of the most backward parts of Nigeria; today it is one of the most developed, with roads, railways, towns, dams, and hydro-electric power installations. There has been an influx of people from many parts of Nigeria, and a large section of the present population has acquired technical skills and experience in labor organization, qualities likely to affect the timing and location of future industrial expansion within the country.

Growth of Mining

European travellers and traders in Nigeria during the latter half of the nineteenth century noticed the "straw tin"[1] being used by the Hausa for tinning their brass, but assumed it was brought over the desert from the north. In the 1880's, however, it became clear that tin had been mined and smelted near Kano for a long time and traded as far away as the Nile, Tripoli, and Ashanti. In 1884 information was first received about the presence of tin on the Jos Plateau, then known as the Bauchi Plateau, but it was not until the Mineral Survey of Northern Nigeria (1904–1909) that the occurrence of tin over wide areas of the plateau was proved.

Covering some 3000 square miles, the Jos Plateau lies at a general level of rather over 4000 feet and forms the watershed between the Niger, Benue, and Lake Chad drainage systems (Figs. 1 and 2). Inselberg topography is common. Even or gently undulating grassy plains are interrupted by several large granite masses, rising to over 5800 feet in the Shere Hills just east of Jos, and by innumerable small hills: granite kopjes, flat-topped low hills of fluvio-volcanic origin, and small extinct volcanoes.

In this isolated and almost unknown country, insecurity and inaccessibility were early difficulties. The first practicable route to the Benue River at Loko (Fig. 4) had to be protected from attacks by pagan tribes. In 1905, for instance, members of the Rukaba tribe were punished for murdering a convoy carrying supplies to the mines.[2] A Government station was opened at Bukuru and serious attempts were made to bring all the plateau tribes under effective administration. By 1910, law and order were sufficiently well established for capital to be attracted to the mines and the "tin rush" began. In 1909 the Niger Company was the only company producing tin (458 tons) on the plateau. During the years 1910–1911 the licensed area increased from 373 to 893 square

[1] "Straw Tin" refers to the tin straws of tin, nine inches or so in length, in which form tin was smelted and traded. The mould was made by inserting grass straws into mud.

[2] F. D. Lugard: *Annual Report for Northern Nigeria, 1905–1906*, London, 1906, p. 391.

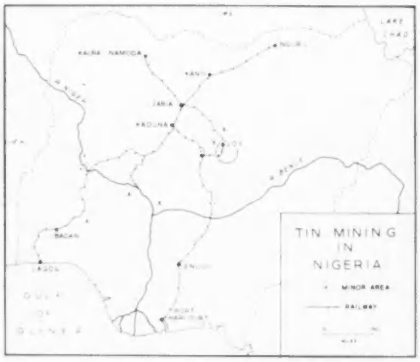

FIG. 1. Tin mining areas in Nigeria. The Jos Plateau is shown as a stippled circle; it is the chief mining area and produces over 90 per cent of the tin in Nigeria each year.

miles and by 1919 there were over 80 companies and syndicates producing 8174 tons of tin.

Difficulties of accessibility remained serious. In the early days, native head-bearers had to carry the tin, as ingots or as black tin in sacks, to Loko. This journey of some 200 miles took about 12 days. From Loko the tin was put into small barges or steamers and conveyed to the Niger-Benue confluence at Lokoja (Fig. 4), there to be transferred to Niger boats and taken to Forcados for shipment to Liverpool. The entire journey from the tin fields to the coast took 35 days and cost £29. 10. 0 a ton. Early reports constantly emphasized the need for railway construction if mining on the plateau was to prosper and subsequent railway building in Nigeria was influenced a great deal in its pattern and timing by the need to reach the Jos Plateau. By 1911 the tin could be carried to the railway at Rigachikum and exported through Baro on the Niger; after 1912 it could travel by rail from Rigachikum to Lagos (Fig. 5). But it was not until 1914 that a railway—the Bauchi Light Railway (2′ 6″ gauge)—reached Jos and Bukuru. Finally, the opening up of the Kafanchan-Jos line in 1927 provided direct rail communication with the eastern line to Port Harcourt, from where all tin is now exported. This 1927 rail link with Port Harcourt stimulated the export of tin by reducing rail freights from £11 to £8 per ton; exports rose from 10,926 tons in 1927 to 13,069 tons in 1928. This connection with the east was also designed to put the tin fields in touch with the chief sources of Nigerian coal at Enugu; this, it was hoped, would both provide power for the mines and encourage the growth of tin smelting at Enugu. By 1927, however, most mining companies had developed their own power on the plateau from hydro-electric sources. There is still no smelting of tin in Nigeria, the native industry at Lirue n'Dalma (*Dalma* means "straw tin") having been suppressed in 1910 in the interests of the European mining community.

Early mining was centered around such places as Polchi, Dubbo, and Juga (Fig. 4), that is, rather to the northeast

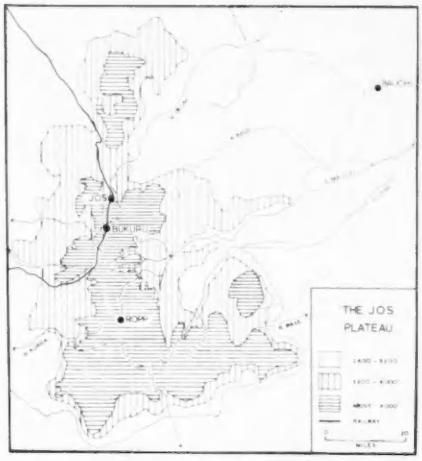

FIG. 2. Most of the tin is mined between Jos and Ropp in the area above 4000 feet. Note the radial drainage, west to the Niger system, south and east to the Benue system, and northeast to the Lake Chad system.

FIG. 3. Dredge on the Jos Plateau. The almost treeless plains are interrupted in the distance by small rocky outcrops, and the activities of the dredge are having locally striking effects on the drainage. (Photo by Aircraft Operating Co. of Africa Ltd.)

of the chief mining area today. The shift in emphasis did not occur because the deposits around Polchi were exhausted, nor was it because of any desire to mine near the railway which in fact postdated the shift. Rather was it due to the realization, as the conclusions of the Government's Mineral Survey became known, that the richest deposits lay between Naraguta in the north and Ropp in the south. The industry has benefited considerably from the early interest shown by the Government in tin mining on the plateau. The 1904–1909 Mineral Survey laid down the best locations before the tin rush began and before the first railways arrived. Consequently, the distribution of railways, roads, towns, and power lines is not now illogical in the present context of mining on the plateau. When the 1927 line arrived from Kafanchan the general pattern of mining was very much what it is today (Fig. 6).

Though production was undoubtedly stimulated by rail communication with

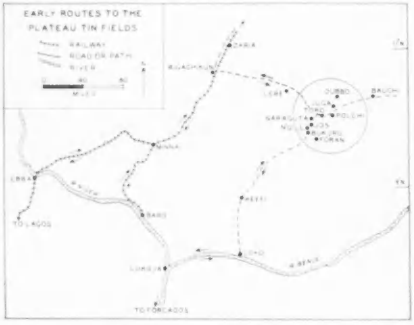

FIG. 4. This diagram applies to 1912. Note that the nearest railway was 120 miles or so away and Loko, on the Benue, some 200 miles away from the tin fields. The circle indicates the approximate extent of the tin-mining area in 1912.

the coast, the major fluctuations in production indicated in Figure 7 reflect events outside Nigeria. Especially is this true of the sharp fall in production during the depression years of the 1930's and of the rise in production during the 1939–45 war when the loss to the western world of Far Eastern sources placed Nigerian tin at a premium. The 1939–45 war saw the peak year (1944) in the industry's history. These sharp changes had several effects. The world depression encouraged the International Tin Restriction Scheme of 1931 which, in Nigeria at least, brought about a reduction in the number of concerns—from 122 in 1929 to 75 in 1933. Other effects were a fall in wages and so in average costs of production which further benefited from Government concessions to the industry. During the war, on the other hand, planned exploitation of the tin fields tended to be replaced by the rapid working of easily worked deposits without due regard for the long-term conditions of the field. Thus the decline in production in the immediate post-war years was due partly to a return to planned prospecting as well as to greater competition, lower demand, and the high cost of getting plant and machinery into Nigeria.

PHYSICAL FACTORS IN DEVELOPMENT

Most of the tin mined is alluvial, and is the oxide cassiterite (SnO_2) derived chiefly from small, locally mineralized zones in the Younger Granite.[3] At its simplest, the geological structure (Fig. 8) may be thought of in terms of (a) the Basement Complex of strongly foliated gneisses and Older Granites; (b) the Younger Granites, which are much more resistant to erosion and weathering and are responsible for the highest features on the plateau; (c) the Fluvio-volcanic series, which are associated with the earliest phase of volcanic activity on the plateau when lavas filled the contemporary valleys and buried the sediments which floored them. The frequent occurrence of tinstone in the basal sands of these deposits gives them considerable potential economic significance, especially where inversion of relief makes adit mining possible; (d) the Newer Basalts, which are asso-

[3] Together with these alluvial tin deposits occurs columbite, of which Nigeria is the world's chief producer, though the demand for this mineral has dropped sharply on world markets recently. During the boom years, some of the productive capacity of the tin mines was diverted to columbite production.

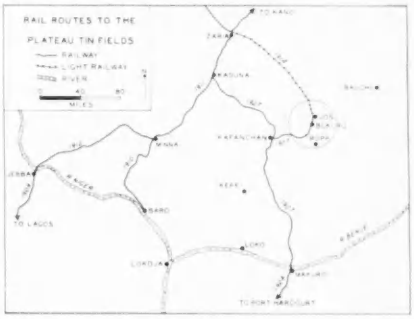

FIG. 5. The dates refer to the year the stretch of line was opened. Note that the eastern line through Enugu to Port Harcourt, from where all tin is now exported, was not opened until 1927.

ciated with the latest phase of volcanic activity.

Alluvial tin, which occurs here as a heavy, dark-colored sand reaching 72.5 per cent pure tin in the exported concentrate, is mined in two main areas: a northern (Jos-Bukuru) granite region and a southern (Ropp) granite region, the two being separated by an outcrop of newer basalts where no tin is mined. In detail, alluvial tin occurs most commonly in river valleys in and around the Younger Granite. Within each valley the occurrence of tin is determined partly by its relations to the Younger Granite and partly by gradient, all the major deposits occurring where gradients average between 25′ and 75′ per mile.[4] It seems that greater gradients prevent the deposition of tin, except in small ravine pockets, and smaller gradients move the sand too slowly for effective concentration.

[4] R. A. Mackay, R. Greenwood, and J. E. Rockingham: *Bulletin No. 19 of the Geological Survey of Nigeria*, Kaduna, 1949, p. 18.

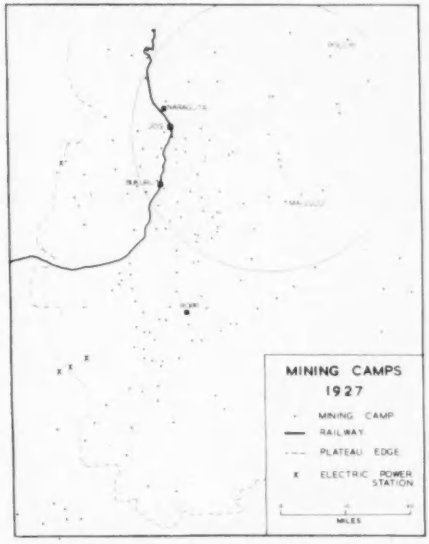

FIG. 6. The circle encloses the area where mining was most important in 1912. It was in 1927, it should be remembered, that the rail link with Kafanchan was opened. Note the relationship of the electric power stations with the plateau edge, though not all were in existence in 1927.

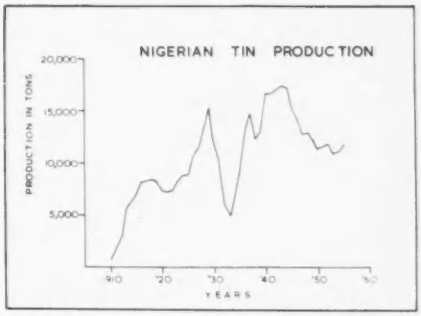

FIG. 7. Production actually began on a small scale in 1904. Note the effects of the 1911–1914 and the 1927 railway developments.

Nigeria is fortunate in that her chief tin deposits occur on open, grass-covered plains.[5] The climax vegetation is probably savanna woodland and several species (for instance, *Faurea speciosa*) have affinities with South and East Africa. Relic vegetation suggests that the plateau may at one time have been tree-covered, and it is true that some deforestation, more especially on valley sides, took place as a result of early mining activities: a 1906 Report, for instance, states that the European staff on the tin mines had "100 pagans constantly employed cutting and carrying wood, clearing bush."[6] But any deforestation on a large scale must have taken place long before the present century. Wood fuel is now very scarce and fuel reserves have had to be established.

In spite of the 50″–60″ annual rainfall, its seasonal and variable characteristics have created difficulties for mining as well as for domestic and agricultural purposes. Most of the rain falls in the six months from April to

[5] This contrasts with the Calabar district of southeastern Nigeria where tin occurs among steep, jungle-clad hills.

[6] W. Wallace: *Annual Report for Northern Nigeria, 1906–1907*, London, 1907, p. 541.

September and varies widely in amount from year to year (Fig. 9). It is also often highly localized, so that data for Jos cannot be taken as representative for the plateau generally. The torrential nature of the rainfall—and the plateau experiences some of the worst storms in Nigeria—causes heavy water losses, soil erosion, and sedimentation. Storm-water protecting ditches are common features of the landscape and conservation works are designed to deal with very high rainfall intensities, reaching over 4 inches in 24 hours. In the early years of modern mining, production was particularly sensitive to the amount of water available for alluvial workings, and as early as 1906 it was recognized that "until the supply of water is conserved by dams to enable mining to carry on throughout the year, the mining activity cannot assume large proportions."[7] Water storage dams have now largely succeeded in dealing with this problem, but the variable water supply has occasionally seriously affected hydro-electric power supplies. As recently as 1950, mining companies had to close down all their electrically operated plants for a period during the dry season. A fourth hydro-electric station has now been opened, as much

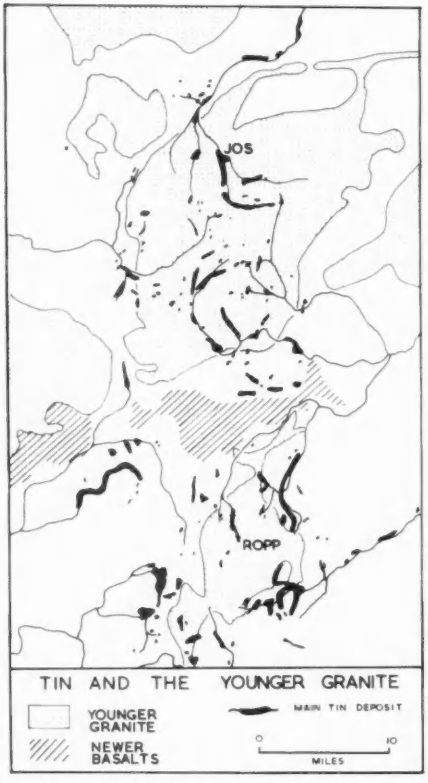

FIG. 8. Note the division of the field into a northern region (Jos-Bukuru) and a southern region (Ropp), the two regions being separated by an outcrop of newer basalts. For the sake of clarity, the solid geology as shown here is greatly simplified. The area left white is chiefly Basement Complex. After R. A. MacKay and Others.

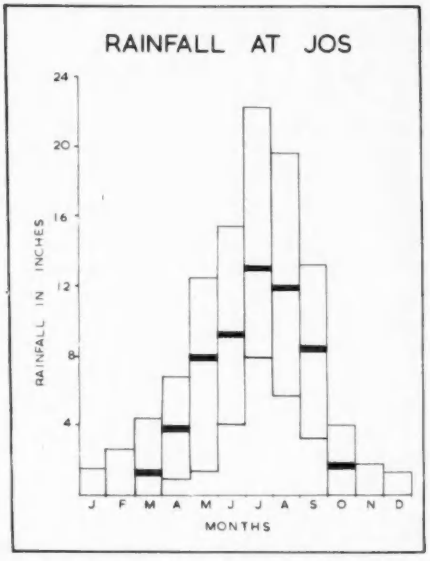

FIG. 9. Rainfall at Jos, 1922–1947. Each vertical bar shows for each month the *maximum* mean monthly rainfall for the period, the *minimum* mean monthly rainfall for the period, and the *median* (the black horizontal bar). These figures, and the picture of variability they suggest, should not be taken as representative of the whole plateau.

[7] *Ibid.*, p. 543.

TABLE I

METHODS OF MINING TIN IN NIGERIA

	Percentage of total yardage	
	1947	*1956*
Open-cast hand paddocks	17.3	40.1
Gravel pumps	19.0	25.8
Dragline	13.3	13.5
Tributing	31.3	6.6
Ground sluicing	6.2	6.3
Dredge	7.2	4.8
Other methods	5.8	2.9
	100.0	100.0

Data from *Annual Reports of the Mines Department.*

to regularize power as to increase its potential.

PRODUCTION METHODS, LABOR, AND COSTS

The Nigerian tin-mining industry provides an example of how the considerations of production methods, labor, and costs are involved in that interrelation of economic and natural features which, according to one writer, it is the function of economic geography to study.[8]

On the plateau, the factors affecting the choice of method include the legislation governing re-soiling, the cost of labor and materials on the spot, capital, the nature and size of the deposits, the availability of water,[9] the nature of the terrain, and accessibility to power lines. The most important methods of mining tin here are by opencast hand-paddocking, gravel-pumping, and dragline work (Table I). This contrasts sharply with Malaya where the relatively slight overburden,[10] frequent and continuous deposits, abundance of water, and gently-graded valleys encourage widespread dredging: in Malaya 51 per cent of the tin is won by dredges against 5 per cent in Nigeria. Table I suggests the decline of tributing[11] and the growing importance of opencast hand-paddocking, though already over half the tin is produced by mechanical methods. Mechanization generally has been made possible by the development of hydro-electric power on the plateau. But perhaps the chief stimulus to the use of mechanical methods is now the cost of labor. Trends in operating costs by various methods (Fig. 10) indicate that hand-paddocking and tributing—which are almost entirely dependent on hand labor—have risen the steepest in cost per cubic yard whereas dredging, in which little labor is required, has remained the cheapest method, though it demands the greatest capital outlay. There is also a tendency to inject new mechanical processes into existing methods: thus experiments are proceeding with the use of jigs which avoid wastage in concentrate and reduce labor requirements. Increase in mechanization on the plateau is perhaps best indicated by changes in the labor production ratio

[8] R. Hartshorne: *The Nature of Geography*, Lancaster, Pennsylvania, 1939, p. 400.

[9] Thus hydraulic mining has in some cases ceased to be economical as the ground under the greatest head of water is worked out.

[10] In Nigeria the overburden is frequently over 80 feet thick. One consequence of this is that the height necessary for gravel pumping with sluice boxes is obtained from the depth of the mine itself whereas in Malaya the generally slighter overburden necessitates in many cases the construction of tall, wooden scaffolding to give the necessary height.

[11] Tributing is a form of mining in which independent laborers work for companies or operators, being paid by results. The most primitive hand methods are common among tributors.

TABLE II

TRENDS IN SIZE OF COMPANY AND OTHER OPERATORS

Year	*Number of companies and private operators producing under 100 tons of cassiterite per annum*	*Percentage of total production of cassiterite*
1938	52	11.2
1948	74	18.8
1950	92	25.6
1954	122	25.8
1955	132	25.2

Data from *Annual Reports of the Mines Department.*

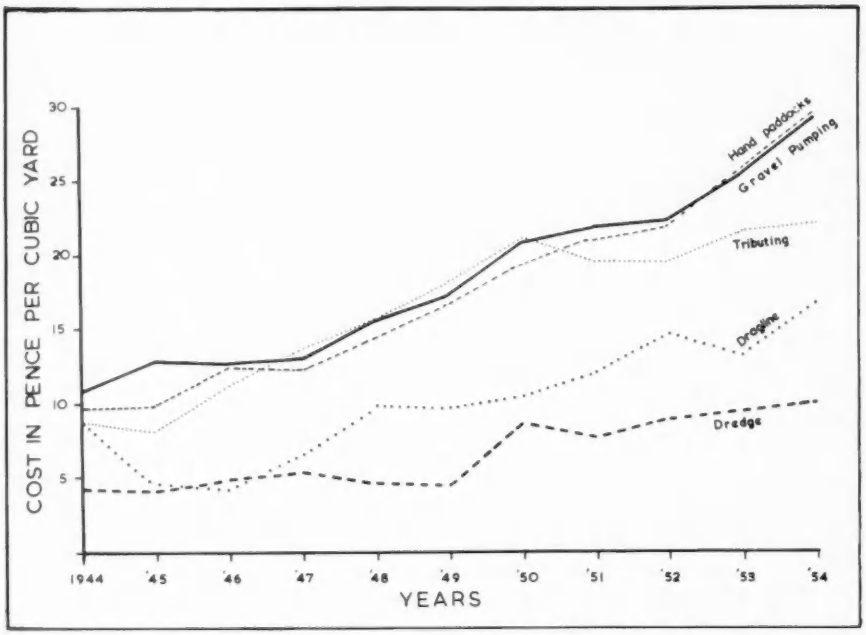

FIG. 10. Trends in cost by methods. The greatest rise in cost per cubic yard has been in hand-paddocks, gravel pumping, and tributing. The first and last of these are almost entirely dependent upon hand labor, gravel pumping to a rather less extent. The smallest increase in cost has been in dredging, which needs little unskilled labor. Dredging, however, is often physically impossible in Nigeria.

which reveal that since 1953 an increased production has been achieved with a smaller labor force (Fig. 11). The cost of labor is rising steadily, and tin mining on the plateau now benefits very little from the lack of competition in the labor market there which formerly made wages considerably lower than in the south of Nigeria. Production costs are also affected by the general decline in the average yield: from 1.01 lbs. per cubic yard in 1948 to 0.76 lbs. per cubic yard in 1956. This question of declining yields, however, is not a simple one: the larger companies often work low grade deposits when market prices for tin are high and leave the higher yielding deposits as an insurance against lower prices.

The costs of mining tin on the Jos Plateau are greater than in Malaya, in spite of the higher wages paid to Chinese miners in the latter area. Apart from the widespread use of the dredge already referred to, Malaya benefits from much lower transport costs: in Nigeria the plateau fields are some 500 miles from the coast, compared with 50 miles or so in Malaya. Furthermore, all spare parts have to be imported into Nigeria whereas in Malaya many of them can be produced by low cost foundries run by Chinese.

It might be expected that the increase in mechanization would be accompanied by an increase in the proportion of tin produced by the larger companies at the expense of the smaller companies and private operators. Trends since 1938, however, show the opposite movement

(Table II). Whereas there were in 1938 only 52 small companies or operators, producing between them 11 per cent of the total production, in 1955 there were 132 such units, producing between them over 25 per cent of the total production. However, the largest company Amalgamated Tin Mines of Nigeria, Ltd. (ATMN) produces some 50 per cent of the total production even today.

SOIL EROSION AND SEDIMENTATION

Soil erosion on the plateau has been the subject of a careful study by Grove,[12] who warns against exaggerating the part played by tin mining. He concludes that mining is but one of many causes of erosion there. A certain amount of erosion is inevitable in an area which is the hydrological center of Nigeria, carries very little natural vegetation, and suffers from short fallow periods, overgrazing, the use of manure as fuel, and the burning of grass. Moreover, the danger to agricultural land of sedimentation from mining activities is rarely a serious problem on the plateau because most mines are well below the surface level of farmland, though gully erosion does tend to lower the ground water level and so to hasten the onset of dry season aridity. On the other hand, silting associated with soil erosion on the plateau sometimes has beneficial effects by raising river beds and so raising the ground water level.[13] It must also be emphasized that many mining works, such as dams and leats, have local retarding effects upon erosion. Nevertheless, it is indisputable that mining has destroyed the continuity of stream profiles in many instances and has led to severe donga development in some districts and to marked alluvial deposition in some of the lower courses.[14] The present rate of destruction of land by mining is some 800 acres a year. Many

[12] A. T. Grove: *Bulletin No. 22 of the Geological Survey of Nigeria*, Kaduna, 1952.

[13] P. Bower: in Part II of *The Economics of a Tropical Dependency* (ed. M. Perham), London, 1948, p. 13.

[14] J. C. Pugh: Ph.D. Thesis (Unpublished), University of London, 1955.

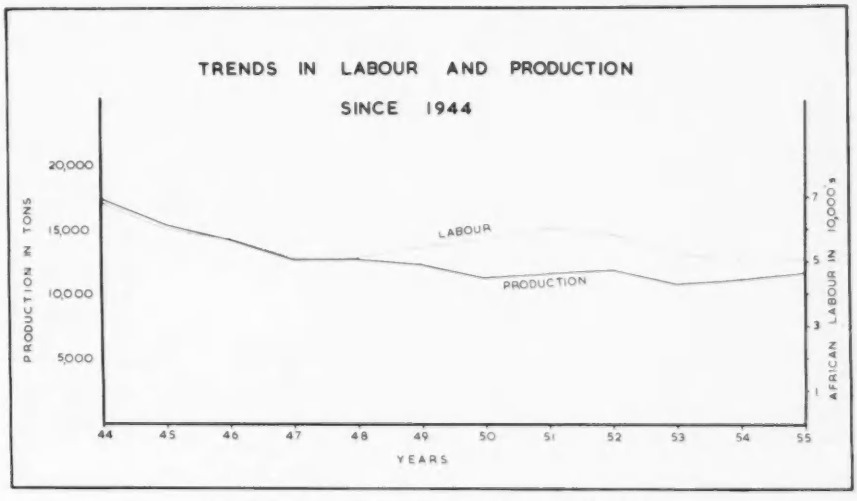

FIG. 11. Trends in production and labor, 1944–1955.

dams have been built and rivers diverted for mining purposes.

Government and mining companies now appear to be fully aware of the dangers of disturbing the soil and drainage systems. The Mines Reclamation Unit is carrying out experiments on levelling and planting on mined land. This unit has already done much work on levelling dumps east of the railway line near Bukuru, the most mined area on the plateau, and experiments are proceeding, for instance at Barakin Ladi, on the growing of trees on old mining dumps. The Government requires mining companies to adhere to regulations governing the removal, stacking, and replacing of soil removed for mining. When the Mines Reclamation Unit deals with the replaced earth, compost is spread on the surface at the rate of about 30–40 tons per acre to increase fertility. Altogether, of the 23 leases already handed over to the unit for levelling, work has now (1957) been completed on 20, totalling some 680

FIG. 12. A pagan village on its rocky site. Note how closely the small round houses are clustered together. Beyond the village stretches the almost treeless grasslands and a wide valley with a little riverine vegetation in its upper courses. (Photo by Aircraft Operating Co. of Africa Ltd.)

acres in extent. Twelve of these leases have now been returned to Native Authorities for handing over to the original owners. This is a feature of some significance, for mining in Nigeria is responsible for most of the alienated land.

Pollution of water by mining effluent is common on the plateau, mined rivers often containing suspended solids reaching to over 5000 parts per million as against 100 parts per million in unmined rivers. In Malaya, the maximum pollution allowed in discharged waters is 800 parts a million.[15] At the moment, however, there seems to be little need on the plateau to control the quantity of solid matter in mining effluents, though this problem may well arise as fuller use is made of surface water resources for hydro-electric power or for irrigation schemes entailing the construction of more dams and reservoirs.

EFFECTS OF TIN MINING ON POPULATION AND ECONOMY

Before the 1900's the plateau was a pagan land, peopled by isolated pagan communities[16] protected behind cactiform shrub hedges (*Euphorbia poissoni*) on rocky outcrops. Large areas of no-man's land remained unfarmed and unsettled. Today the plateau has a population of over half a million, almost half of whom are urban dwellers, mine workers, traders, or cattlemen. Security and the impact of new ideas have brought some of the pagans downhill and in some cases they have moved off the plateau altogether. On the other hand, traditional pagan communities still live on their isolated rocky sites, and in general the pagans of the plateau have shown little enthusiasm for taking part in mining as a full-time occupation, though they increasingly take part in temporary casual work, after harvesting and before the rains begin, for cash to pay taxes or to buy some specific article. So temporary and unreliable is such labor that some companies are seriously affected by the return in April of pagans to their fields where they may stay until October. According to Grove's calculations, the average pagan farmer is actually better off on his farm than if he were to work continuously in the mines.[17]

FIG. 13. Part of the plateau south of Bukuru, showing (a) pagan villages and fields in the top left-hand corner, (b) extensive mining operations along the river valleys, (c) regular patterned mining and labor camps, (d) European houses in the top right-hand corner, and (e) a main road and railway crossing the photograph vertically (the railway on the left). (H. M. Government.)

[15] A. T. Grove: *op. cit.*, p. 22.

[16] The local connotation of pagan is any non-Moslem indigene.

[17] A. T. Grove: *op. cit.*, p. 27.

Though tin mining has not greatly affected the pagan's occupational structure, it has taken away some of his land and it is often stated that tin mining has been responsible for widespread population pressure on the plateau. However, probably not more than 35 square miles have been lost to pagan farmers by tin-mining activities. Moreover, tin mining is most common on land of poor quality agriculturally. Only occasionally, as in Gyel Village, where one-seventh of the total land was diverted from food production by mining, has mining been a locally significant factor in producing population pressure.[18] And in such cases efforts have been made to resettle or rehabilitate displaced pagans: the new cotton ginnery at Kuru, for instance, is meant to provide employment for upwards of 100 displaced pagans, chiefly Birom. Where tin mining has affected population pressure is in establishing stable conditions in which the pagan abandoned his thrifty, laborious methods of cultivation, using terraces, and adopted shifting cultivation which rapidly became grass fallowing with very short fallows as the population of the plateau increased. One of the results of this has been a decline in soil fertility and greater susceptibility to erosion.

From the population point of view, the most important effect of mining on the plateau has been to attract large numbers of "strangers" from all parts of Nigeria to work on the mines and as traders: at the last census (1952) as many as 44 per cent of the total population of Jos Division were classed as "strangers." The immigrant nature of the mines-field population is further reflected in the sex ratio: in Jos Division the ratio is 1094 males to 1000 females and in Jos Township it is 1777 to 1000.

Over one-third of these "strangers" on the plateau are Hausa traders and mine workers. Fulani cattlemen, too, were attracted on to these fly-free plains with a growing market for dairy produce. Where engaged directly in tin mining, the population shows some occupational specialization by communities. The bulk of the owners, managerial staff, and dragline operators are European; skilled or semi-skilled laborers and headmen in charge of sluice boxes are usually Hausa, whereas fitters, electricians, and clerks are commonly Yoruba or Ibo. Unskilled laborers, including all those working with picks, shovels, and headpans are usually illiterate Hausa or pagans, including women.

The growth of "stranger settlements" on the plateau has occurred without any appreciable effect on the original settlement patterns of pagan communities. Europeans and Hausa have almost alone been responsible for the urban settlements of Jos (40,000) and Bukuru (9000) and the more strictly mining settlements like Sabon Gida. Initially, most of these settlements had the haphazard pattern typical of rapidly growing pioneer mining towns, and anything in the way of an orderly layout is of even more recent origin, Bukuru, for instance, having been laid out in 1929. Most mine laborers, however, live not in the towns at all, but in labor camps built for them by the mining companies and to them, as at South Ropp, are usually attracted Hausa trader settlements. Other settlements, such as Maijuju and Fusan Hausawa, have developed as markets for the mining areas.

Sociological problems associated with the impact of strangers on the pagan peoples of the plateau are as yet little apparent. Most observers agree that the pagans have remained remarkably little

[18] J. G. Davies: "The Gyel Farm Survey in Jos Division," *Farm and Forest*, Vol. VII, No. 2, Ibadan, 1946, pp. 110–114.

TABLE III

NIGERIAN DOMESTIC EXPORTS (F.O.B.)

1956

	Value (£ sterling)	*Percentage of total exports by value*
Groundnuts	27,764,351	21.0
Cocoa	23,984,606	18.0
Palm kernels	20,439,959	15.5
Palm oil (edible)	12,154,988	9.5
Tin	7,297,490	5.5
Cotton	7,112,834	5.4
Others	33,414,628	25.1
	132,168,856	100.0

Data from *Nigeria Trade Summary*, Vol. 41, No. 12, Lagos, 1956.

Note: (i) The Nigerian Government also receives over half a million pounds sterling annually from tin royalties, apart from mining fees and rents. All mining rights have been vested in the Government since 1950.

(ii) To put Nigeria in world perspective, the country lies sixth among the tin-exporting countries: Malaya (56,000 tons, 1956), Indonesia, Bolivia, Belgian Congo, Thailand, Nigeria (11,500 tons, 1956).

affected by outside influences, though changes in the internal structure of pagan communities have been noticed, the power of the chiefs having declined most in those parts of the plateau where mining has been most active. Changes in the nature of land tenure have also been indicated. Moreover, there has been some friction between the Fulani cattlemen and the pagan. On the other hand, the economy of certain pagan communities depends very largely directly or indirectly upon the tin mines, some communities, for example, making the collection and sale of firewood their chief occupation. Then the very presence of a large non-agricultural population in the towns and camps provides the pagans with opportunities for wide local markets for surplus agricultural produce, an opportunity which so far they have not been quick to grasp: most of the food used by urban and mining communities is still imported. Rather have the pagans tended to rely on the tin mines to supplement their own food supply by providing cash earned in the mines. This is an undesirable situation, for if mining comes to an end there is likely to be a serious food shortage.

THE FUTURE

The imminence of national independence in Nigeria makes the future of the industry as a largely European controlled proposition uncertain, and agitation is already strong to nationalize the industry. Yet there has been little increase in recent years of African participation in the managing and ownership of mining operations. Though the percentage of total production produced by companies incorporated in Nigeria has risen from 8 per cent to 17 per cent since 1947, these companies are in fact largely British owned. On the other hand there has been a relative increase in the proportion of Nigerian private operators and of the 13 firms operating under Registered Business Names, 11 are Nigerian owned. The present trend seems to be, in fact, for African participation in ownership and management to increase slowly, but for it to be confined to the smaller organizations and private owners. That African participation should increase is certain. Their limitations nowadays are not so much capital as skills and organizing experience at managerial levels.

The future prosperity of the tin-mining industry on the Jos Plateau must depend to some extent on adequate reserves. It is impossible to prognosticate confidently about these, but there seems to be no immediate cause for concern. The most recent estimates indicate reserves of 134,822 tons, a figure which is higher than estimates of a few years ago (127,000 tons in 1951). Moreover, exploratory adit mining will decide whether the deposits under the Fluvio-Volcanic series are in fact a commercial proposition.

Much more serious for the industry's future than the question of reserves, not only in Nigeria but throughout the world, is the possible expansion in technological economies in world tin utilization. The International Tin Agreement, ratified in 1956, is designed to prevent undesirable fluctuations in the price of tin and to maintain the floor and ceiling prices at £730 and £880 a ton respectively. To keep production in line with consumption, however, severe restrictions on output have already had to be enforced in all countries adhering to the Agreement. In Nigeria, output has been reduced in this way by two-thirds for the first three months of 1958. As Table III suggests, such retrenchments will not necessarily have any great repercussions on the Nigerian economy as a whole. On the other hand, the effects of these output restrictions on the plateau economy have been immediate, including the laying off of almost 15 per cent of the mines labor force. If output restrictions are continued, the plateau may well become a depressed area.

The answer to this problem must clearly be to widen the basis of the plateau economy. Conditions are unusually suitable. Jos is gradually assuming the role of economic capital of the northeastern region of Nigeria, and the projected new railway from the plateau to Maiduguri, and possibly beyond to the Sudan, would further emphasize the plateau's nodality. On the plateau, too, there are already the beginnings of a tourist industry, and the provision of better all-season access roads from other parts of Nigeria and West Africa would undoubtedly encourage more people to visit the cool, open grasslands of the Jos Plateau. Local food supplies can also be expanded, partly by utilizing for irrigation the water bodies originally dammed and controlled for mining purposes. Above all, however, there is scope on the plateau for rapid industrialization, utilizing the power resources, lines of communication, urban amenities, and the skilled and semi-skilled labor force built up by the mining industry. This, at least, was the conclusion of the International Bank Mission of 1954 and is supported by most recent observers. The tin mining industry has given the plateau a legacy which must now be invested in a broader based and more stable economy.

ACKNOWLEDGMENTS

I am grateful to the management of Amalgamated Tin Mines of Nigeria (ATMN) Ltd., for their kindness and help to me while on the plateau.

THE BANANA INDUSTRY IN WESTERN SAMOA*

R. Gerard Ward

Mr. Ward is a lecturer in geography, University of Auckland. The field work on which his article is based was carried on during the period of October, 1956, to January, 1957, and is part of a wider survey by the Department of Geography of the University.

IN 1960, Western Samoa is scheduled to be the first of the United Nations Trusteeship Territories in the Pacific to become self-governing and independent of its trustee power. The success or otherwise of this venture in self-government may well depend on whether or not the country can become economically independent.

With a restricted range of tropical crops and no mineral or other resources which might provide foreign exchange, Samoa is virtually committed to continued dependence on its present export trilogy of copra, cacao, and bananas. The world market for the first two is, at the moment, relatively sound, but the United Kingdom Ministry of Food contract for copra, which has operated since 1948, expired at the end of 1957 and greater fluctuations in price may be expected in the future. Since the war, cacao prices have fluctuated considerably, ranging from £109 per ton in 1946 to £390 in 1954. The future for these two major crops is, therefore, not altogether certain so that the significance of the banana export trade with its assured market in New Zealand is obvious. During the period 1952–1956 bananas have accounted for 13.5 per cent of the total value of exports and have provided 62.5 per cent of Western Samoa's exports to New Zealand. Nearly 20 per cent of the total income of Samoan villagers from agricultural products is received from the sale of bananas. Bananas, however, are important not only as an export crop but also for the very important part they play in the Samoan food supply. Along with taro and coconuts they form the basis of the Samoan diet,[1] and this fact has an important bearing on the quantity available for export. In any period when supplies of alternative foods are low the home consumption of bananas rises and the export volume falls rapidly.

With the expansion of the volume of exports in recent years the effect on the pattern of land use has been marked while the addition of an extra source of cash income has had its effect on the social situation in this semi-subsistence economy (Fig. 1). It was estimated in the F.A.O. census that bananas accounted for 20 per cent of the area used for agriculture in 1950. Detailed land use maps of some 20 villages indicate that, with interplanting, 30 per cent of the agricultural area was in bananas in 1955–1956. This increase in acreage

*Thanks for financial assistance are due to the University of New Zealand Carnegie Social Science Research Committee.

[1] No full study has been made of food consumption in Samoa but an experimental survey made in conjunction with the *1950 Survey of Food and Agriculture in Western Samoa* by the New Zealand Department of Agriculture indicated that bananas provided 30 per cent of the daily consumption of fruit and vegetables by weight. The total consumption for 1950 was estimated at 727,450 cwt. so that with an export volume of 77,950 cwt. some 90.3 per cent of the total crop was consumed in Samoa in that year. Since then the proportion exported has increased to an estimated 30 to 40 per cent.

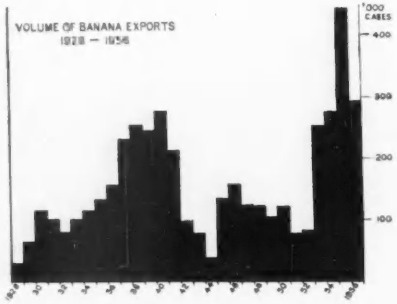

FIG. 1. Since March, 1953, bananas have been exported in 73-lb. cases. Prior to that, 90-lb. cases were used, but figures have been modified so that all totals in this graph are in terms of 73-lb. cases. (Based on *Annual Reports on Western Samoa 1928–1956*, Department of Island Territories, Wellington, New Zealand.)

was accompanied by a 350 per cent increase in exports from 1950 to 1955.

Western Samoa consists of two main islands, Upolu and Savai'i, with two smaller inhabited islands, Manono and Apolima, lying between them (Fig. 2). The group lies some 650 miles to the northeast of Fiji and 1800 miles northeast of Auckland, New Zealand, the destination for most of the bananas exported. Apia, the only town and the export port for all produce lies in a central position on the northern coast of the eastern island, Upolu, which, although it is only 430 square miles in extent compared with Savai'i's 700 square miles, has 72 per cent of the group's population of 97,327 (1956). In 1956 over 86 per cent of the bananas exported came from Upolu, reflecting the easier access which all parts of this island have with the port. Only the eastern part of Savai'i shares in the banana export trade and, owing to lack of transport, neither Manono nor Apolima supply fruit.

Over 82 per cent of the population lives in villages strung around the coasts, and banana growers in these villages supply over 95 per cent of the export fruit. The population of the villages ranges from under 100 to over 1600. The plantations[2] extend inland from the villages for up to five miles to where bush clothes the central ridges reaching to over 3000 feet in Upolu and 6000 feet in Savai'i. The majority of plantations lie below 850 feet.

[2] The term "plantation" is used in Samoa for both the commercial ("European") plantations and the Samoan "gardens," and is so used in this paper.

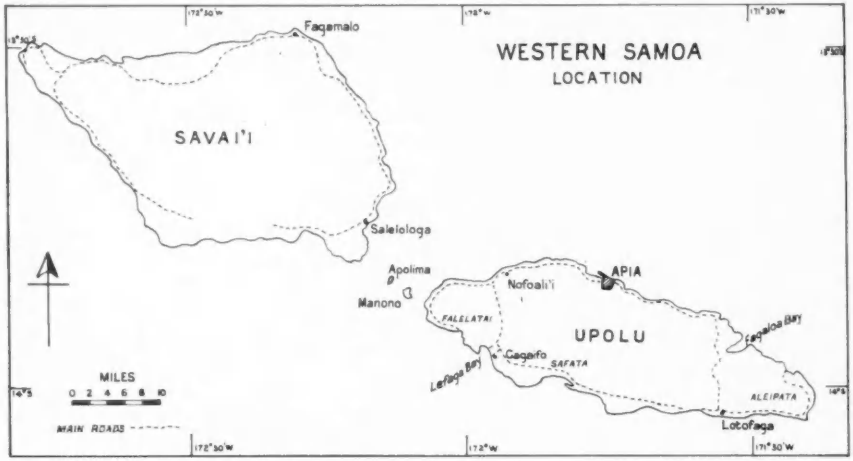

FIG. 2. Locational details, Western Samoa.

THE VILLAGE SYSTEM

The social and economic organization of the villages remains basically traditional. Within the village the unit of organization is the *aiga*, a family group with a wide foundation of membership based on descent, adoption, and marriage. At the head of each *aiga* is the *matai* whose title carries with it the *pule*, or authority, over the land used by members of the *aiga*. The *matai* is theoretically responsible for managing the family lands, organizing the work force from day to day, looking after the general welfare of the group, and representing the *aiga* in the village councils. Previously, it was normal for the *matai* to allocate tasks each day to the *taulele'a* (untitled men) and women in the plantations, fishing, or working around the village. Today, however, it is common for the *matai* to permit one of the *taulele'a* to use one or more of the plots of family land as he wishes. This is particularly true of newly cleared land where *taulele'a* sometimes assume those rights of occupation formerly exercised only by a *matai*. Although this allows the *taule'ale'a* to plant whatever crops he likes it does not necessarily give him any security of tenure.

The land held by each *aiga* is split into a number of plots scattered throughout the area occupied by the village. A *matai* is likely to hold (on behalf of the *aiga*) anything from five to fifteen plots and the number may be increased by clearing new patches from the bush. Title is established simply by clearing a patch of bush and is maintained by continued use of the piece of land. It is unusual, however, for one person to establish title to a large consolidated block for if it appears to other members of the village that one individual is clearing an abnormally large block they are likely to clear around the "offender's" holding and prevent him from enlarging that particular plot. If a person is of sufficient standing in the village, however, he may be able to dissuade the other *matais* from such a course and to allow him to clear and use a considerable area.

The scattered distribution of the plots of each *aiga* ensures that each family has some land in coconuts, bananas, taro, and usually some cacao. The pattern of land use is much the same from one village to the next. The village is almost invariably situated on the coast with the agricultural land extending inland up the slope. Amongst the *fales*[3] and around the *malae* (village green) are scattered coconut palms, breadfruit trees, and a few clumps of bananas. Behind the village and extending inland is a zone of coconut palms and scrub. Occasionally, bananas or cacao may be planted under the palms, but this is rare for here the soil has been depleted through long use and the failure of bananas to produce fruit has discouraged growers from planting in this area. Furthermore, village pigs are liable to damage bananas planted close to the *fales*. Moving inland one passes from the coconut zone to a belt where patches of cacao and bananas are interspersed with areas of scrub and creeper. This scrub represents a fallow in the simple rotation. Newer planting takes place on recently cleared land along the margin of the bush. Here are most of the village's taro plots, set in the midst of a space of grass and creepers which again represents a fallow. Bananas encroach on this area which is in turn extended by clearing.

Almost every *aiga* will possess two or more pieces of land, varying in size

[3] The *fales*, or houses, are usually of native construction with thatched roofs and open sides. Plaited blinds may be lowered if necessary.

from a half to three or four acres, in each of the three major land use zones.

AGRICULTURAL METHODS

The size of banana plots varies considerably and an *aiga* may have anything from 50 to 500 banana stools scattered in four or five plots. Those planters who have established themselves as reliable suppliers of fruit and who therefore obtain bigger export quotas will have larger areas in bananas. Within the plots the stools are usually regularly spaced from nine to twelve feet apart, but as suckers are rarely pruned the clumps spread and cover a much larger area than the optimum. Size of bunches and quality of fruit suffers accordingly, and the old stems continue to deplete the soil and help spread disease. Likewise the standard of weeding is low and grass and creepers compete with and at times overrun the banana stools. Rarely do the bananas provide sufficient cover to shade out the weed growth. The loss of moisture through weed growth is no doubt significant during dry spells but this is not realized by the majority of growers. This general lack of care is also seen in the selection of planting material. Only on the larger, atypical plantations which are usually operated outside of the village system, are any significant attempts made to carry out regular weeding, pruning, and selection of planting material. The only regular care which is carried out by most planters on anything approaching a satisfactory standard is dusting with insecticide to prevent scab moth damage. In the past Samoa was considered to be relatively free from serious crop diseases and banana pests, and only recently have the dangers been realized. Recent research has indicated that the crop loss for bananas through disease and pests may be as high as 25 per cent in some areas. In 1955 and 1956, bunchy-top (a virus disease spread by the aphid *Pentalonia nigronervosa*) spread rapidly in southern Upolu and was one of the causes of a marked drop in production in the latter year.

In the worst affected district (Lefaga) over one quarter of the banana stools were infected and in one village the figure was over 50 per cent in the latter year. Preventive measures including spraying and the cutting out of infected plants have been only partially effective, in part because of the lack of understanding by the growers of the necessity for these measures. Spraying trials have been carried out to try and combat the ravages of scab moth and banana weevil borer. Research is at present being conducted in Fiji on the introduction of a parasite which it is hoped will bring the scab moth under control and, if it proves successful, the parasite might well be tried in Western Samoa. After stools have ceased to produce fruit, frequently through the exhaustion of the available supply of nitrogen and potash, a plot will be abandoned and a new one established elsewhere. The old stools are often left standing and thereby assist in the spread of disease and delay the recuperation of the soil.

The low standard of banana plantation care is a reflection of the generally low application of labor to the land. This is related to the low social status accorded to skill and diligence in agriculture.

The system of shifting the plots, often after only three or four bunches have been obtained from a stool, has led to an increase in the perimeter of production of each village. New land is cleared farther from the village and in some areas most of the bananas are now produced on plots up to four miles from the village and the road. Fruit

must be carried on horses or manhandled over muddy tracks to the packing depots on the roads. The quality suffers accordingly and the difficulties have discouraged producers in some villages. Abandonment of land and the consequent decline in production has been most marked in eastern Upolu.

Until the present time no fertilizers have been applied by Samoan growers and shifting cultivation techniques remain in use. The period for which production of satisfactory bunches may be obtained from any plot depends basically on the inherent fertility of the soil and its past land use history. All the soils are derived from flows of olivine basalt, the oldest being found in the east. On the steeper slopes of northeastern Upolu, soil creep and the continued weathering of the plentiful supply of rock fragments result in a steady renewal of the supply of plant nutrients and here is found the most stable land use pattern with banana plots continuing to produce fruit of export quality for up to ten years. Small areas of alluvial soils in the narrow valleys are of similar quality. Elsewhere, where slopes are less steep and weathered material accumulates *in situ*, the replacement of nutrients is slower and the bananas may produce for only three or four years. The situation is worst in those areas where coconut palms are growing and which have therefore been under continuous use for 60 years or more. Here it is not uncommon to find that bananas will not fruit at all. Initial fertilizer trials have indicated that the soils of the areas which have been cultivated for some years are generally deficient in potash, phosphates and nitrogen but more experiments are needed to indicate what quantities are required. With the introduction of the use of fertilizers it should be possible to stabilize the land use pattern to a much greater degree and to intensify the use of the area already cleared. The intercultivation of coconuts and bananas should also be possible except where palms are planted too close together.

It has been suggested that it will not be feasible to introduce the use of fertilizers until the majority of producers, namely the *taulele'a*, are given more security of tenure over the land they work. It would appear, however, that once the growers can be convinced of the benefits which will accrue as a result of the application of fertilizer there should be little difficulty in encouraging its use. It may be necessary at first to use some element of compulsion and make the granting of export quotas conditional upon the regular application of fertilizer. Such a system, or a modification of it, has proved successful in encouraging regular dusting to prevent scab moth damage, and in the Cook Islands a similar scheme has been introduced in connection with the use of fertilizers on tomatoes.

GROWTH OF SUPPLY AREA

The export of bananas from Western Samoa was begun in 1928 with the area west of Apia providing the bulk of the fruit. Two years later, the supply area was extended to include Fagaloa Bay, Lefaga, part of Safata, and a small area in eastern Savai'i (see Figure 3). These areas were favored in that despite the fact that they had no road links with Apia, breaks in the reef allowed coastal launches to load bananas with relative ease. In 1934, the Falelatai area began supplying fruit. Since then the extension of the supply area has followed road development.

Although small quantities of fruit were sent out over the reef from Aleipata and Falealili between 1952 and 1954, road links between these areas and

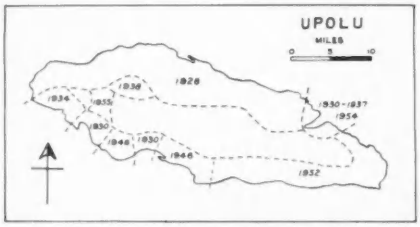

FIG. 3. Map of Upolu showing the years in which banana exports were begun in the various areas. (Based on records of Banana Scheme.)

Apia were established in the latter year and enabled a more reliable service to be provided. In the past four years road development in Savai'i has made it possible to extend the supply area to include the whole of the eastern half of the island. Fruit is shipped to Apia from wharves at Salelologa and Fagamalo. It appears that it will not be economical to include western Savai'i in the fruit supply area until the creation of a deep water port at Salelologa eliminates the necessity of exporting all fruit through Apia.

Figure 1 indicates the extent to which the volume of exports has fluctuated since 1928. The availability of shipping space has proved a major problem ever since exports were begun. As early as 1930, it was officially stated that, had more reliable transport been available, exports would have been higher. The effect of lack of shipping was most marked during the war years, while the great increase in production in 1953 was coincident with the provision of a second ship with refrigerated cargo space to provide a fortnightly rather than the previous monthly service. The decline in exports in the depression years of the early 1930's followed the reduction of both the price and the demand for bananas in New Zealand.

EXPORT ARRANGEMENTS

Since 1954 all the arrangements connected with the export of bananas have been made by the "Banana Scheme," an organization which is virtually a separate government department. Recently the Department of Agriculture has taken over control of the allocation of quotas to the growers. Marketing and distribution within New Zealand is in the hands of a commercial firm, Fruit Distributors Limited, and the price f.o.b. Apia is negotiated between this firm and the representatives of the Samoan government.[4]

Bananas are exported in 73-lb. cases and timber for these must be imported from New Zealand. Prior to a shipment being made, timber is distributed to the growers' roadside depots where the cases are put together. Meanwhile the growers have been allotted quotas which in most instances are between five and twenty cases. A few growers send up to 100 cases per shipment. On the receipt of picking notices, there is great activity in the village plantations, with bunches being selected, cut, and carried to the roadside depots. There the bananas are stripped from the hands and packed singly. At a prearranged time, the cases are collected by trucks, or, in some areas remote from roads, the bananas are taken out over the reef to coastal launches. All these operations are timed so that the fruit arrives in Apia during the 48 hours when the ship is in port. All cases are opened in Apia, inspected for quality of fruit and rejected if necessary.[5] The cargo is finally lightered out

[4] In 1956, this price was £1.0.9d per case. Of this, the grower received 9/–, with the main charges per case being as follows: case (timber), 7/–; labor and internal transport, 2/3d; export duty, 6d.

[5] The rejection rate is at times nearly 10 per cent with immaturity of fruit being the major cause. This is particularly marked when bananas are in short supply and growers endeavor to maintain their quotas by picking immature fruit. The emphasis on quality through inspection has resulted in a premium price being paid for Samoan bananas as compared with

(*Continued on next page*)

to the ship anchored in the roadstead. At present, there are two ships with refrigerated space operating between Samoa, Tonga, Fiji, and New Zealand and for the greater part of the year fortnightly visits are made to Apia.

EFFECTS OF BANANA PRODUCTION

Since 1928 there has been a steady increase in the area in bananas. Quick growing and non-permanent, bananas already formed an integral part of the Samoans' system of shifting agriculture, and at first sight it might appear that the increase in planting to cater for the export market would have little effect on the land use pattern. This has not proved to be the case and the expansion of the area in bananas has had some far-reaching results.

Access is of prime importance to the banana grower and the completion of the road to any village is likely to set off a wave of banana planting. The prospect of adding another cash crop to the village economy, previously dependent on copra and possibly cacao, is attractive and the normal pattern is for considerable areas to be planted in bananas soon after the road is pushed through. The initial planting usually takes place on land which has been lying in a fallow of grass, creeper, or scrub. Frequently, plots are established under the coconut palms and on occasions new land is cleared from the bush, though this is unusual in the initial stages.

Increases in the area in bananas are usually accompanied by corresponding decreases in the area of scrub and a general shortening of the fallow period results. This has led to the more rapid use of plant nutrients and to poorer yields of fruit. The banana has become one of the most important elements leading to the shortening of the rotation period and to the widening of the perimeter of agricultural land.

Even if depots are allotted to enable all the fruit produced as a result of the initial burst of activity to be sold, the area in bananas is likely to decline after a year or so. In part, this is due to poor yields from trees planted where soils have already been depleted through long cultivation, but other factors are also significant. Usually in the first rush of indiscriminate planting, little attention is given to the distance the fruit will have to be carried to the roadside depots or to the amount of sustained work which is necessary to maintain steady production. Planters who do not fill their quota with reasonable regularity, or who send in poor quality fruit, may lose their depots and abandon their attempts at this type of commercial agriculture. Others tire of the regular work entailed, find that it is too difficult to get the fruit to the roadside, or become discouraged when they find that a considerable proportion of the income gained from their exertions must go to the *matai* and the *aiga*. Abandoned plots, with the bananas overgrown with grass and creeper, are common sights.

Frequently, cacao is planted with the bananas, and in this practice lies another cause for the eventual reduction in the banana acreage. At first, the bananas provide shade for the young cacao but must be removed later to allow the cacao to mature. With the replacement of the temporary crop by the permanent one, the planter must move his banana plots further from the village, a process which may involve the clearing of bush and the carrying of the fruit over longer distances. Within anywhere from three to six years, the actual time depending on the fertility

those imported into New Zealand from Tonga and Fiji. In 1956, the price paid for Tongan and Fijian fruit was 19/– a case as compared with 20/9d for Samoan.

of the particular soil, the location of plots in relation to the village and the road, the attitude of the *matais* towards the income earned by the *taulele'a*, and other factors, the area in bananas will have declined and stabilized. Production, too, will have declined from the peak reached in the first two years.

Until the present time, the steady construction of roads bringing new areas within easy reach of Apia has enabled banana production to be maintained, and in favorable years increased, despite the tendency for production to fall off in the older districts. In this way a wave of banana planting and production has passed around most of Upolu and the eastern half of Savai'i and is now spilling over into western Savai'i. Until harbor facilities for overseas vessels are available in Savai'i most of the western half of the island will have to remain outside the banana production circle. It is evident, therefore, that the initial production wave cannot be expected to maintain export totals indefinitely and already there are signs that in the near future increases in production must be based on much more far-reaching measures than the mere provision of main roads and the allocation of new depots. Soon the attempt must be made to increase production from the land which has been used recently and abandoned for only a short period. This can be successful only through the introduction of fertilizers, the improvement of weeding and pruning techniques, and the elimination of pests and diseases. The success of these measures depends largely on how well new techniques can be introduced into the agricultural system without disturbing the social system. The introduction of what at first sight are straightforward measures, such as the use of fertilizers, will require a great deal of careful and tactful extension work on the part of the agricultural officers concerned and it is possible that these steps will have a far-reaching effect on the whole system of social and land organization.

The introduction of cash crops into the village economy has already proved a major stimulus for change. The wave effect of initial plantings and the short time which elapses between planting and full production may have made the influence of bananas more marked than that of any other single crop. Bananas must be picked and packed to a rigid timetable imposed from outside the village. This is not so with other crops so that, in the case of banana growing, we see a factor operating to lessen the degree of internal control of activities and the effective authority of the *matais*. Most depots are operated by *taulele'a*, largely independent of the *matais'* authority, and for many young men this provides their first major experience of independent action in agriculture.

The fact that income from bananas is received regularly, either fortnightly or monthly, rather than twice or three times a year as is the case with cacao, also makes the crop more significant as a continuous agent of change in the social system. The traditional system whereby the produce (or more recently the cash returns) from the land was given to the *matai* to distribute amongst the members of the *aiga* no longer applies in many cases. There is little doubt that the fact that payment for bananas was formerly made in Apia to the individual growers, most of whom are *taulele'a*, was an important factor in hastening this change. Many growers made a point of spending the greater part of their money before they returned to the village. Thereby they avoided handing over the cash to the *matai*. Some *matais* of course permitted the grower to retain all or most of the

cash in any case. In either event, the fact that the *matai* was no longer the person with direct authority over the whole income of the *aiga* removed one of the bases for his authority. With the *taule'ale'a* increasingly independent in the economic sphere, there is a growing tendency for him to desire to be independent socially and politically. This is reflected in such things as the tendency for more and more young people to live on their plantations rather than close to the *malae*. The establishment of "private" banana plantations, outside the village system, provides further evidence of these changes. As yet, relatively few people are involved in this latter development with its far-reaching implications, but the number has grown in the past three years and it is clear that their influence is out of all proportion to their number.

FACTORS AFFECTING PRODUCTION

Although the village economy is relatively simple, the factors influencing the production of cash crops are numerous. As in any area, rainfall, soil fertility, and ease of access are important, but of at least equal importance are such things as the low place which skill in agriculture has in the Samoan standards of value, the social harmony of the village group, and the extent to which the group makes demands on the individual's time and energies. The interaction of these and other factors helps create marked regional patterns, and in the following paragraphs some of these factors and the regional differences which result from them will be examined.

Temperature is not of great significance either in limiting the areas suited to banana growing or in causing variation in production. At sea level, average monthly temperatures vary little—from 77.8° F. in July to 79.5° F. in January and February—while the absolute minimum recorded at Apia is 61° F. Curry has shown that average monthly temperatures are above 68° F. for all months up to elevations of about 2500 feet.[6] This means that low temperatures provide no bar to banana growing over virtually all of Upolu and most of Savai'i. As yet most banana plantations lie below 850 feet, but as higher land is planted it will be found that temperature will become more significant. On the only banana plantation above 1800 feet, production of a mature bunch from the time of planting takes up to two months longer than on the coast.

Variation in rainfall and the occurrence of drought conditions is a much more important factor. Annual rainfall is over 100 inches throughout Samoa except in the extreme northwest of the two main islands. In northern Upolu and Savai'i two marked rainfall seasons are found with the peak of the wet season extending from December to early March and with minimum rainfall from June to August. Elsewhere, the division into wet and dry seasons is not so clear and rainfall is fairly evenly spread. Curry[7] has calculated that in the occupied areas (i.e., at lower elevations) of northwest Upolu and Savai'i, potential evapotranspiration will exceed rainfall in June, July, and August in at least one year in two. Elsewhere, drought probability is less and in eastern and southern Upolu the danger of severe dry spells is slight.

Planting continues throughout the year in most districts. Only in the northwest sections of the main islands is there any marked tendency towards concentration of planting activity in the

[6] L. Curry: "The Physical Geography of Western Samoa," *N. Z. Geographer*, Vol. 11, No. 1, April, 1955, p. 36. Only one station (Apia) records temperatures regularly so that information is limited and conclusions must be tentative.

[7] *Ibid.*, pp. 38–39.

rainy season. Detailed export figures for individual villages are available only since 1955, and there are no accurate yield statistics for any experimental or other areas. This, together with the paucity of rainfall stations and the incompleteness of many of their records, makes it impossible to do more than draw tentative conclusions about the relationships between availability of moisture and production. The period plants can withstand lack of rain varies greatly from one part of Samoa to another owing to the great variation in the water storage capacity of the soils. The reaction to a dry period is especially rapid on the thin, extremely rocky soils of the greater part of Savai'i and in more restricted areas in Upolu. On these recent lava flows with their small pockets of weathered material and expanses of bare porous rock, water storage is negligible. Northwest Upolu, the area most susceptible to drought conditions, is more fortunate in that there is generally a greater depth of soil and water storage capacity is higher. These assumptions are borne out by the few figures which are available. In northwestern Upolu production can be maintained through two months, each with under four inches precipitation and through one month with a water deficit (assuming four inches of water storage). If more than two consecutive months occur with water deficit, production drops rapidly and will not start to rise until two or three months with water surplus have elapsed. Irrigation is not practiced in Western Samoa.

Excess rainfall is not a significant problem as virtually all soils are free draining. It should be noted, however, that prolonged and heavy rain over the days allotted to picking can quick y turn village tracks into quagmires so that villagers are unable to pick and pack their fruit and hence quotas may not be filled.

One of the major problems of the banana industry as a whole is the sudden fluctuations in production which occur from month to month. The causes of these fluctuations are varied, though the major changes on a national scale are usually due to shipping difficulties or climatic conditions. Bananas provide a major food staple and the greater part of the total crop is consumed in this way, so that the relatively small surplus available for export may be greatly affected by slight changes in the level of local consumption. Thus, if taro is in short supply due to lack of foresight in planting, dry weather, damage to plantations by wild pigs, or any other reason, the banana exports of the village or area concerned will drop. Production from a district frequently falls as a result of the diversion of labor into other village activities, or through the disruption of work by disputes within a village over land, social organization, or local politics.

The export section of the crop is especially susceptible to any disturbance in work routine. With few urgent economic needs to fill in an economy which is only semi-commercial, the preparation of cash crops for sale is a secondary or "luxury" activity and one of the first to be neglected if other activities compete for time or energy. In contrast, community affairs such as church or school building, religious or other festivities, road construction, and so on have a high social importance and take precedence over such mundane activities as work in the plantations. The diversion of a large part of a village's labor force into these community activities may lead to the neglect of plantations for months on end. The bare minimum of weeding, pruning, and planting will be done, food-crop plant-

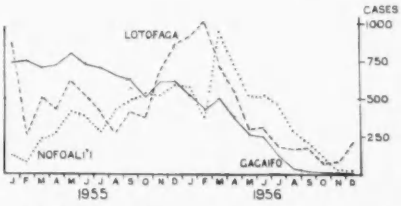

FIG. 4. Monthly banana exports for sample villages in 1955 and 1956. The latter part of 1956 was extremely dry and production fell in all districts. (Based on village shipment returns of Banana Scheme.)

ings may not be maintained, and bananas will be consumed locally rather than exported.

The graphs for sample villages indicate the extent to which production may fluctuate from month to month (Fig. 4). Likewise, Table I shows how the share of national exports of the various regions may vary from year to year. Until the effect of many of the social disturbances on the work routine can be reduced, these fluctuations in production are likely to continue. This can only come about by impressing on the growers the necessity for and the benefits of regular production, and this in turn will probably depend on an increase in the extent of individualism in agricultural activities and especially in the realms of land tenure and economic gain.

Table I indicates that within Western Samoa the intensity of production of export bananas varies greatly, from 21.3 cases per head annually in the Lefaga region to 1.2 cases in East Savai'i.[8] Ease of access to Apia, the relation between bananas and other crops in the land use system, the amount and quality of land available, climate, village attitudes, and the competition of other activities help to account for these areal differences. How these factors interact in specific cases may be indicated by a brief description of the various regions. Figure 5 indicates the regions into which Samoa has been divided and to which Table I refers.

When the export of bananas was begun in 1928, all the fruit was supplied by villages in Northwest Upolu and this region has produced export fruit continuously since that date. Since 1928, its share of the country's total production has declined to an average of 26.5 per cent during the last three years. Exports per head of population

[8] No entirely satisfactory statistics are available to indicate production per acre. In 1950 it was estimated in the F.A.O. census that the average yield per acre was around 6500 lbs. which is low compared with the 4 to 8 tons which can be obtained on well-managed plantations. Sample studies made in 1956 produced no evidence that average yields per acre had increased.

TABLE I

YEAR-TO-YEAR CONTRASTS IN PROPORTIONS OF NATIONAL BANANA EXPORTS CONTRIBUTED BY THE SEVERAL REGIONS (SEE FIGURE 5)

Region	*I*	*II*	*III*	*IV*	*V*	*VI*	*VII*	*VIII*
1954 (percentage)	17.7	11.7	1.4	5.1	36.4	18.1	6.2	3.4
1955 (percentage)	26.4	15.5	2.9	4.5	27.9	13.4	6.2	3.2
1956 (percentage)	35.2	14.4	3.9	5.5	18.6	10.1	5.1	7.2
1954–1956 (percentage)	26.5	14.1	2.7	4.9	27.7	13.8	5.9	4.4
Cases exported annually per head population 1954–1956	3.7	6.3	2.2	4.5	15.9	21.3	7.7	1.2

Regional Names

I—Northwest Upolu
II—Northeast Upolu
III—Fagaloa-Aleipata
IV—Lotofaga
V—Safata
VI—Lefaga
VII—Falelatai
VIII—East Savai'i

Based on Banana Scheme records of village exports.

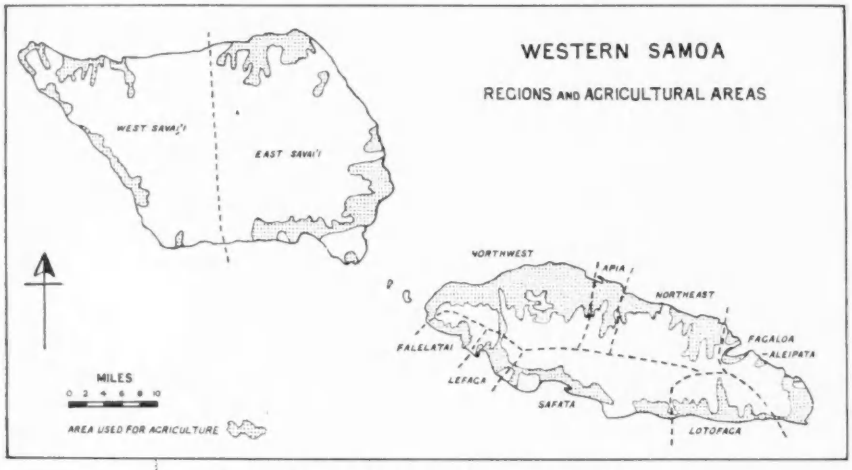

FIG. 5. Regions of Western Samoa. See Table I.

are low—only 3.7 cases per year (1954–1956).

Northwest Upolu has a denser population than any other region except urban Apia while the area of village agricultural land per head of population is low, averaging .9 acres compared with 1.7 acres for Western Samoa as a whole. In this region are found the majority of Samoa's commercial coconut and cacao plantations and these account for 40 per cent of the total agricultural area.

The shortage of land and the fact that the land of most villages takes the form of long narrow strips extending back from the coast means that there is an inordinate length of village boundaries per unit area. Disputes over these boundaries are not uncommon and frequently land close to the margins of a village's area is left in scrub to form a belt of "no man's land." There is little accessible bush which might enable the agricultural area to be extended.

Pressure of population has resulted in a quickening of the rotation of food crops (including bananas) so that in this region, land is rarely allowed to remain unused more than two years. The fertility of the soil has been depleted and over the greater part of the region bananas will not produce fruit for more than two years. This, together with the example of the commercial plantations and a favorable climate has led the Samoans to plant considerable areas in cacao, thus further restricting the area available for bananas.

With a larger income from cacao, and with greater opportunities for employment on commercial plantations or in Apia, villagers living in Northwest Upolu have less incentive to grow bananas for export than Samoans in more remote areas.

All these factors tend to reduce the significance of bananas in the village economy of this region. That the region is still able to supply over one quarter of the country's export bananas is due to the presence of a number of independent growers on freehold or leasehold land. These planters, Samoans or part-Samoans working outside the village system, include the largest individual suppliers in the country and their success is a measure of what may

be done if security of tenure and freedom from some of the more onerous social obligations is obtained.

Northeast Upolu was also an early supplier of export fruit. Here, however, the land is steeper with the village plantations extending for several miles up narrow valleys. With few vehicle tracks the problems of transporting the fruit to the roadside depots are considerable. These difficulties are offset to some degree by the fact that on these sloping lands soil fertility is relatively high and production can be maintained for up to seven years before plots must be abandoned to scrub. Furthermore, the absence of commercial plantations in the region has led to a greater emphasis being given to cash crops and during the last three years production of bananas has been increasing. In at least one village, this is attributable to the influence of a single energetic *matai* who has been instrumental in encouraging agricultural production as a matter of village pride. Recent efforts by the Department of Agriculture to stimulate production by similar means and by advice and guidance have met with considerable success in the same village.

In the eastern half of this region the last five years have seen a great increase in coconut and cacao planting so that, with a smaller area available for bananas, production may fall unless new areas of bush are cleared. To date, the distance of the bush from the village and the lack of vehicle tracks has meant that clearing has not kept pace with production and there has been a tendency to shorten the period of scrub fallow. Greater production may well depend on the provision of better access.

The region with the lowest production per head in Upolu (the urban area of Apia is excluded) comprises the districts of Fagaloa and Aleipata in the extreme east of the island. The reasons for this low production are varied. In the Fagaloa Bay area, there was no road access prior to mid-1957 and the road is not yet suitable for laden trucks to negotiate. All produce must, therefore, be taken out of the bay by boat and lack of shipping space caused the cessation of exports in 1937. Shipping space is still limited and there has been little incentive to expand production since exports were resumed in 1954. This is probably advantageous in the long run for around Fagaloa Bay the land rises steeply and little unused land is available. Already slopes of over 60 per cent are cultivated, but the land use pattern is stable and, with soils which enable banana production to be maintained for over seven years, is likely to remain so. However, a sudden expansion of the area in any one crop and the consequent clearing of even steeper land could bring extremely serious consequences to the villages of the area.

Aleipata district which forms the eastern half of the region has a similarly low production but the reasons for this are different. Following the construction of a road through the area in mid-1955 considerable areas were planted in bananas in an attempt to expand exports. In this, the district was merely experiencing the planting boom which has swept through most villages. But here, long cultivation of the gently-sloping land had already depleted the soil to a considerable degree and the yield of fruit was low. Only on land newly cleared from the bush were results satisfactory and these areas were up to four miles from the road. The difficulties have discouraged the majority of would-be growers and it seems that, until roads provide better access and the use of fertilizers allows increased production from "worn out" land, the

banana exports of this region will remain low.

In the neighboring region of Lotofaga, the export of fruit was started at the same time as in Aleipata, the road link with Apia was provided at the same time, and a similar planting boom followed. But here the soils are of higher inherent fertility and the road provided easy access to considerable areas of bushland. Banana plantations were quickly established along the road, partly to provide a title claim through clearing. Although production suffered as a result of the abnormally dry conditions of 1956, the prospects for increased production in this region are good. The speed with which land was brought into production along the new road illustrates the effectiveness of the provision of access as a stimulus to agriculture and, even if this clearing of bush is only a short term measure, the establishment of an agricultural cooperative in one village of this region may prove of more lasting significance in encouraging better plantation care.

Safata is the country's leading region in volume of banana exports (1954–1956) and is second in terms of exports per head. Since 1954, its share in national production has declined. With fertile soils and with roads passing through the center of the plantation areas, the region is more fortunate than most. That its share of national production has fallen is due in part to the drought conditions of 1956 and in part to social factors. Since the road along the south coast was completed there has been a tendency for some persons, usually younger folk, to move from the villages on the shore and to live on their plantations close to the road. Lack of water away from the coast has hindered this trend but in two cases the shift has reached the stage where new churches have been built and the whole village moved. While these major shifts have been in progress the agricultural production of the villages concerned has dropped as labor has been diverted to other tasks. Once the shift of the villages has been completed, renewed bush clearing may be expected and, with *fales* centrally situated in relation to their land, less time will be wasted in travel to and from distant plots.

The highest production per head in recent years has been in the Lefaga region. With fertile soils, good road links with Apia, and good road location within the region, Lefaga has been able to maintain high production for over twenty-five years. However, exports dropped from 27 cases per head in 1955 to 13 cases in 1956. This is the result of one of the first major outbreaks of crop disease in Western Samoa. Surveys in 1956 showed that 28 per cent of the banana stools in the region were infected with bunchy-top and in the worst area the figure rose to 54 per cent. Attempts at eradication have been only partially successful and there are signs that the disease is spreading from this center eastwards into the Safata region.

Falelatai has soils similar to those of Lefaga, but production per head is only one-third that of the latter region. This is apparently due to two factors: the greater likelihood of dry spells between June and August and the fact that the only road in the region follows the coast whereas the majority of banana plots are several miles inland.

In Upolu, the initial wave of banana planting has passed through most villages. In Savai'i the wave is now at its peak in some areas. The island's share in national exports has increased from 3.4 per cent in 1954 to 7.2 per cent in 1956 and, with road construction, an increasing area is being brought within the economic transport radius of the wharves of Salelologa and Faga-

malo. Production per head is still low in East Savai'i and West Savai'i is still outside the supply area and until port facilities for overseas vessels are available in Savai'i shipping space to Apia will limit the volume of fruit which may be exported. Over all, the intensity of use of agricultural land in Savai'i is low compared with Upolu and much greater areas of bush are as yet unused. Once transport problems are solved, the prospects for a steady increase in banana production are much greater in Savai'i than in Upolu.

CONCLUSION

Late in 1958, the provision of more shipping space between Western Samoa and New Zealand will make a considerable increase in banana exports possible, provided the extra fruit can be produced. Since the late 1930's when exports were almost as high as they have been in the last four years, the population of Western Samoa has increased by almost 60 per cent. The agricultural area has not been increased correspondingly. Already there are signs that production cannot be expected to increase indefinitely without considerable improvements in agricultural techniques. Measures such as the opening of new forest areas for cultivation through the construction of access roads are merely temporary expedients and must be accompanied by more efficient use of the land already cultivated. This can only be accomplished through the education of growers and the introduction of basic measures such as improved plantation care and the application of fertilizers. It is probable that such innovations will have far-reaching results not only on agriculture but also on the village social system in general. Modifications of the land tenure system may be necessary. The successful introduction of such measures in Western Samoa will depend not simply on the demonstration of the fact that they are financially profitable but also on whether or not they can be injected into the agricultural and social systems without causing too much disturbance. Already the production of bananas for the export market has proved a significant agent of change and this influence is increasing.

In the past, attempts to bring about basic changes in the village social and land tenure systems have produced strong reactions. The next few years may show whether or not sufficient of a commercial economy outlook has yet been absorbed by the Samoan villagers for them to accept such changes in the interests of increased cash income.

ACKNOWLEDGMENTS

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AGRICULTURE IN SOUTHERN NIGERIA (EXCLUDING THE CAMEROONS)

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THERE is some confusion in the definition of terms used to classify indigenous systems of tropical agriculture, and disagreement with regard to the success of the methods employed. It was shown in a previous paper[1] that "shifting cultivation" has been regarded by some writers as an all-embracing term for indigenous systems of tropical agriculture and by others as a term applied to only one system. While some have concluded that the methods of tropical cultivators are well adapted to the "natural" (especially the soil) conditions, others have described them as wasteful and in need of "reform." Recent research in tropical Africa has added considerably to the stock of information on the subject of tropical agriculture and has revealed the existence of a variety of cultivation methods. In the light of such information it would seem useful to apply the geographical approach to the study of the various systems of cultivation used in a particular region and to describe their distribution and their relationship to the physical environment.

Southern Nigeria provides a sufficient number of examples to serve as a suitable field of study. For the purpose of this paper the region is defined as that part of Nigeria in which two crops may be planted in succession in a single season on land dependent on rainfall for moisture supply or in which crops needing at least six months rainy season may be grown (chiefly roots). Southern Nigeria is, therefore, the area having over six months rainy season, *i.e.*, six months each with at least four inches of rain, and having two or more rainfall maxima in most years[2] (see Figure 1).

There are six systems of cultivation in Southern Nigeria:

1) Shifting cultivation: in which virgin land or land supporting a well-developed secondary vegetation is sought for planting and in which cultivation involves movement of the settlement.

2) Rotational bush fallow: in which the area of cultivation rotates through a fixed area of fallow grasses or woody plants in which woodland is not allowed to regenerate. The settlement site is permanent.

3) Rotational planted fallow: in which the only important distinction from rotational bush fallow is that the fallow cover is selected and planted.

4) Permanent cultivation using manures, compost, or household refuse, often complementary to the above systems.

5) Tree cultivation, also permanent

[1] W. B. Morgan: "Some comments on shifting cultivation in Africa," Research Notes, Department of Geography, University College, Ibadan, No. 9, 1957, pp. 1–10.

[2] From the cultivator's point of view the expectation of two or more rainfall maxima in most years is a more important concept than two or more maxima in the monthly averages. For convenience the isopleth limiting the areas having two or more rainfall maxima in 75 per cent of years recorded has been used in Figure 1.

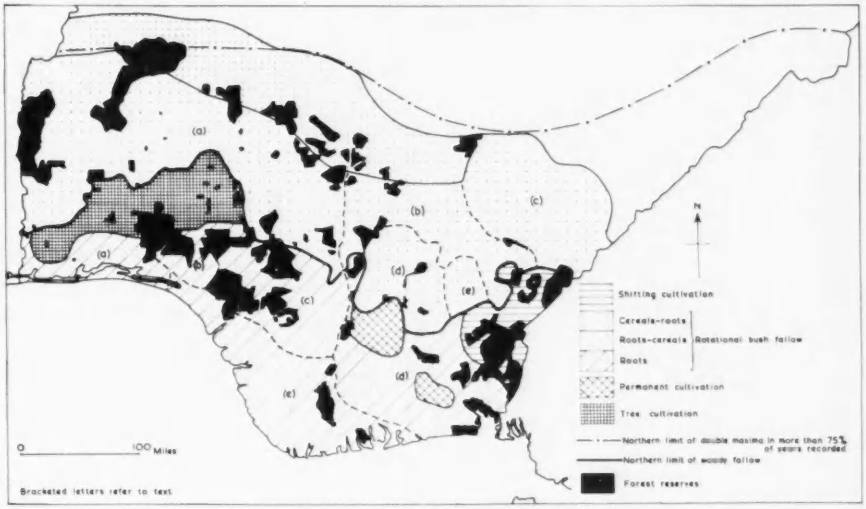

FIG. 1. Agricultural regions of Southern Nigeria.

and usually associated with rotational fallow systems of cropping.

6) Flood land cultivation, also permanent due to the annual renewal of soils and usually complementary to the systems mentioned.

The distribution of these systems is illustrated in Figure 1. The regions shown are generalized and are gradually changing both in character and distribution.

Systems 4, 5, and 6 are complementary. Systems 1, 2, and 3 are the chief systems of cultivation. It is important to stress the differences between the latter and not to group them together as several varieties of one basic system of "shifting cultivation." Admittedly, they are sometimes difficult to distinguish from one another, yet the differences between them are of fundamental importance and produce different relationships to the physical environment. These are frequently related to different social and economic conditions. Despite these differences there are some common features which need preliminary discussion here. Firstly, except in the extreme southeast, cultivation in Southern Nigeria has a "rest period," produced by lack of water. This period is everywhere less than six months and mostly less than three. Compared with Northern Nigeria which has a much longer "rest period," there is less time in any one year for soil recuperation and in consequence fallows tend to occupy a greater proportion of the cultivable area. Secondly, the systems of cultivation in no way resemble "farming" in the European sense. They are small scale (virtually gardening), use few implements, in most cases are as much concerned with subsistence as production for sale, make no direct use of animals, and have little manure or fertilizer available to maintain or improve the soils. The lack of manures is especially marked in the woody fallow areas where pastures are difficult to maintain. Thirdly, in most cases only the right to use the land may be possessed, not the land itself, and there

is thus little incentive to improve soil fertility. Fourthly, the variety of crops grown permits mixtures and rotations while the long growing season permits crop successions. Land may frequently be kept in use for more than one season before it must be rested due to declining returns. Fifthly, the cultivators all use field systems and have ordered patterns of land use. Finally, tillage is in almost all cases deep (often more than a foot) and normally involves the construction of ridges or mounds.

SHIFTING CULTIVATION

Shifting cultivation is only possible in areas of low population density, generally less than 25 persons per square mile, although the figure must vary according to vegetation and soil conditions. Land is chosen for tillage on the basis of the type, height, and density of the plants it supports. The system flourishes in well forested areas with a marked dry season where burning is easy and an abundance of ash may be heaped on the crop land. The wetter areas in the south with little or no dry season and constantly high humidities are less suitable, except possibly near the coast and between the Niger River and the Cross River where highly porous soils provide well drained conditions supporting a vegetation possibly easier to clear. Almost the sole remaining areas of Southern Nigeria where shifting cultivation still occurs are in the lands of the Boki peoples, and of the Ejagham clan of the Ekoi in the extreme east (Fig. 1).

The Boki peoples[3] with population densities averaging less than 20 to the square mile moved into the lower lands of the Cross River basin during the last century, cultivating chiefly plantains and cocoyams. Traditionally, their main "farms" are established in clearings in high forest land. For plantain cultivation they prefer the deep soils of newly cleared land along the lower slopes of the hills. Recent crowding in some areas due partly to modern commercial and political influences and partly to loss of land to forest reserves has encouraged a tendency to establish smaller secondary yam and maize "farms" on land previously cultivated. Boki villages are easily moved since they rarely contain more than 500 people and usually only about 200. The Ejagham Clan moved into the Oban Hills during the last century where they likewise established clearances for the cultivation of plantains and cocoyams supplemented by yams and a little cassava. Their holdings average between one and two acres and "fallows" appear to last for a minimum of 15 years. However, considerable restriction in movement has been imposed by the loss of vast areas to forest reserves. Elsewhere, there is evidence of the former practice of shifting cultivation amongst the Tiv peoples and amongst the northeastern Ibo before overcrowding made it impossible. Yam cultivators like the Yoruba, Ibo, and Tiv have always been encouraged to seek virgin land wherever possible since the yam produces much more abundantly on newly cleared forest soils. The restriction of root crops like the yam to areas with long wet seasons and the necessity for early cultivators to find forest easy to clear suggest an original development of the shifting cultivation of yams on the northern fringes of the evergreen rain forest in areas with a marked although short dry season. Further important features of shifting cultivation to note are:

(a) cultivation is often undertaken with very little tillage since so

[3] J. H. Mackay: *A regional survey of the Ikom-Oban area*, unpublished MS., dated 1944.

much time is spent in clearance;
(b) the system is at least in part a response to a lack of variety of crops making rotation impossible or very limited;
(c) there is little attempt to distinguish soil types except where these are reflected in the vegetation;
(d) fields are generally formless, although planting is often in rows for greater convenience;
(e) the system is highly individual with a settlement pattern of scattered family units.

ROTATIONAL BUSH FALLOW

Rotational bush fallowing is the chief system of cultivation used in Southern Nigeria. It depends on the regular use of fallow which is never permitted to revert to woodland. The cultivable land is divided into rectangular fields, quite often possessing permanent or nearly permanent boundaries. The settlement is fixed or moves only a few yards at a time within the compass of a fixed site. Permanent cultivation (system 4) of a small area of "compound" or "kitchen garden" land is usually associated. The system occurs in divisions having population densities between approximately 50 and 600 per square mile. The fallow area is restricted although still greater than the planted area. It consists of self-sown plants on land formerly under crops and changes in character with the length of period which it is allowed to remain undisturbed.[4] Clearance for fresh planting is normally undertaken on fallow land and not in virgin or well developed forest. In this there is an advantage in labor. Nadel wrote of the Nupe: "Clearing virgin land is, in fact, considered such heavy and inconvenient work that the farmers, especially those who cannot count on the assistance of a large working group, make all efforts to avoid taking virgin land under cultivation."[5] Fallow is not judged by the length of time it has remained uncultivated, but by the type, height, and density of vegetation it supports. In the more crowded districts fallow plants are regularly cut down when they reach a certain height, which varies greatly with differences in physical conditions and in fallow area available. Environmental differences bring differences in the type of fallow which in turn produce differences in the type of rotational bush fallowing. In Southern Nigeria there is a major distinction between the area with grass fallows and the area with woody fallows (see Figure 1). In the former, grass is pulled, cut, or burned before digging and the task of clearance is not difficult. In the latter the cutting and uprooting of woody plants followed by their burning must take place before tillage and is an onerous task. The larger trees are commonly left partly to ease the work and partly to provide tie poles for yams. In the grass fallow area clearance often occurs in large "blocks" and the fields are open. In the woody fallow area clearance is usually in smaller lots, although there are exceptions notably in Southern Iboland, and the fields are hedged in by tall bushes and contain useful trees like the oil palm plus the stumps of trees killed by girdling and burning.

Environmental differences also affect the crop mixtures, rotations, and successions on which rotational bush fallowing depends to offset the lack of virgin

[4] Some indication of changes in the character of fallow is given in R. Ross: "Secondary succession in the Shasha Forest Reserve, Ecological studies on the rain forest of Southern Nigeria," *Journ. of Ecology*, Vol. 42, No. 2, 1954, pp. 259–282.

[5] S. F. Nadel: *A Black Byzantium*, 1942, p. 215.

land. Crop mixtures enable a high density of plants to be obtained on a given patch of ground without too much competition for limited soil resources. Increased density may give higher total production per unit area although lower production by each individual plant. It provides a protective cover against heavy rains, and helps to reduce the area which must be weeded. Crop mixtures occur amongst shifting cultivators, but are usually limited by the smaller variety of crops available. Amongst rotational bush fallow cultivators as many as five different crops may be planted in a single plot. The plants occupy different positions on the ridges or mounds of earth heaped up by the cultivator. Thus yams are commonly at the top, maize on the sides, and cassava in the furrow. Often the members of any given mixture are planted in succession over a period of a few weeks in order to spread the labor of planting and sometimes in order to enable the most important plant to become established before competing with the others for moisture. In Iboland this principle is extended so that yams are commonly planted in February and March with the first rains, and are followed by cassava interplanted in July and August just before the second rains. In the wetter, woody fallow areas the only cereal of any importance is maize, which is of major significance in crop mixtures in the Yoruba and Bini areas of the west. In the grassland fallow areas where the dry season is longer, cereals become of equal or greater importance in the mixtures and include maize, Guinea corn, and bulrush millets.

True successions, that is planting after harvest in the same plot during a single season, are not as common in Southern Nigeria as the planting successions discussed above. In the woody fallow areas with a rainy season of more than nine months in the year there is a concentration on root crops needing eight months or more to mature and in consequence little possibility of succession. In the grass fallow areas despite the shorter rainy season quick growing cereals maturing in three months or less occasionally make possible two crops in succession. Thus two maize crops sometimes follow one another while the Nupe often follow bulrush millet or maize with beans, melons, or cassava.

Crop rotations are used to extend the period of cultivation possible on any plot before abandonment to fallow. The rotations are not of single crops, but of mixtures of crops. Several of the rotations used are regular, but others are what de Schlippe calls "pseudorotations," that is ". . . a certain customary order of field type (mixture) successions produced by improvisation within the framework of limitative rules . . ."[6]

On the whole the grass fallow area can produce a greater variety of crops than the woody fallow areas and it is in the former that crop rotations, successions, and mixtures are more developed and also more important since these areas are marginal for many of the crops grown and careful tillage and planting are essential. The different rotations of crop mixtures can be used to distinguish rotational bush fallow regions as follows:[7]

[6] P. de Schlippe: *Shifting Cultivation in Africa: the Zande System of Agriculture, 1956*, pp. 207-210.

[7] The regions given and illustrated in Figure 1 should be compared with the regions of the Sample Census of Agriculture, 1950–1951, Lagos, 1952. The latter are the result of estimates before the census took place and are "crop" regions rather than agricultural or cultivation regions based firstly on the distinction of the system of cultivation and secondly of crop mixtures and rotations. References to returns per acre, crop production, or acreages under a given crop in the text are based on information derived from the Sample Census.

I. Grass fallows

1) The cereals-roots region with cereals dominant.

The rainy season is just long enough for satisfactory root production in most years, but generally the cereals, Guinea corn and bulrush millet, give more reliable returns. The region is marginal both for cereals and roots and on the whole yields per acre are low.[8] Guinea corn occupies the greatest area and provides the greatest weight of any one foodstuff. Yams appear to be an historically recent introduction to the region while cassava was introduced by the Hausa after the turn of the century.[9] A typical rotation amongst the Nupe is: 1st year, yams; 2nd year, maize, Guinea corn, and early and late bulrush millet; 3rd year, early and late millets and Guinea corn; 4th year, cassava, sweet potato, and beans. Fallows normally last four years. Yams appear first since they need rich soils to produce satisfactorily, while cassava is normally last since it is tolerant of a wide range of soil conditions, takes 12 months or more to produce, and can be harvested for several years after planting. Occasionally, cotton or groundnuts take the place of yams in the first year. Yams are planted mainly at the beginning of the dry season, in mounds when the soils are still soft enough to be worked after the rains. In the second year the mounds are converted to ridges for cereal planting. After the maize and early millet harvest the ridges are shifted so that late millet and Guinea corn are left in the furrows. The new ridges are planted to late millet and Guinea corn "thinnings" and sometimes to beans. A similar process occurs in the third year. Fourth year tillage for cassava planting is generally only slight. A notable feature around Bida where land is short is the common omission of yams from the main cropland rotation and their cultivation in large mounds in flood land. On the whole the Nupe make more use of manure than do other peoples of Southern Nigeria. In the Bini districts, for example, Fulani herders are encouraged to pasture on future cropland.

2) The roots-cereals region with roots dominant.

For the most part Guinea corn occupies the greatest area of any single crop, but the greatest weight of food is produced by yams which in those parts best served by road or railway are also important commercially.

(i) The Western districts (a).[10] In the west amongst the Ilorin and Oyo Yoruba and to a lesser extent amongst the Kabba Yoruba and the Igbira a common practice is to clear the land and to dig ridges for the planting of maize and Guinea corn in the first year. After the Guinea corn harvest which follows the harvesting of maize the stalks are bent and tied to form a trellis, the ridges are "mounded," and yams are planted during the dry season. Thus the yam vine is provided with a trellis for climbing and the work of providing poles in areas often crowded and short of timber is avoided. Maize is usually interplanted with the yams

[8] Areas to the north have some yam cultivation, for example, among the Katab and Mumuye and several peoples in Southern Plateau Province, and sometimes two cereal harvests in a year, although rarely two widely spread plantings. In Leaba in northern Nupe it is impossible to follow the normal practice in areas with a longer rainy season of leaving part of the yam tuber in the ground after the main harvest, in order to produce a seed (*A Black Byzantium*, p. 220). In the northeast the Jukun are within the zone climatically possible for double cropping or roots (Fig. 1), but traditionally employ a "northern" system of cultivation. Roots and beniseed have gained some ground in recent years due mainly to Tiv influences, but Meek in 1931 listed cassava and beniseed as only minor crops and made no reference to yams (C. K. Meek, *A Sudanese kingdom*, 1931, pp. 404–413).

[9] *A Black Byzantium*, p. 2.

[10] Bracketed letters refer to Figure 1.

and two crops may be obtained in one year. Cassava often follows in the third year and appears to be increasing in acreage with growing commercial importance. Where long fallows are possible the ridges may be shifted to the furrows and instead of cassava, maize, Guinea corn, and yams follow again before fallowing. In some Yoruba districts, cowpeas are planted with the second rains before yam planting and after picking remain as a cover crop over the yam mounds.[11] In the southwest of the region maize is very important and often begins the rotation. In the northwest cotton and tobacco are important secondary crops. Yam cultivation is well developed in Southern Borgu despite the marginal location since long fallow land is abundant and there is a good road to southern markets. In parts of Kabba and in almost the entire area east of the Niger yams are normally the first crop in the rotation and yields per acre are much higher than elsewhere.

(ii) The Eastern districts. The districts east of the Niger can be subdivided into the following: *Igala-Idoma* (b) with mainly three years cropping of 1: yams; 2: maize, Guinea corn, and bulrush millets; 3: cassava and beans. Yams and particularly cassava have in recent years become important commercial crops for export by road and railway. *Tiv* (c) with 1: yams; 2: Guinea corn and bulrush millet; 3: beniseed, cassava, and groundnuts in the south; and 1: yams; 2: millet or Guinea corn and beniseed in the north. A common practice amongst the Tiv is to plant one piece of cassava stalk in each mound several weeks before planting yams at the beginning of the rains. The cassava provides a trellis for the yam vine to climb. Beniseed is the chief commercial crop of the Tiv and provides the cash for the payment of tax.[12] Its cultivation has been greatly encouraged by government agricultural officers. *Northern Ibo* (d) with the mixed cropping of yams and cassava, harvesting the cassava planted in the first year throughout the second. Cereals are of only slight importance and with high population densities (Nsukka division 342 persons per square mile; Udi, 309), fallows are short and returns per acre low. Cassava has become the chief crop of this sub-region. *Abakaliki* (Northeastern Ibo) (e) with large holdings of two acres or more concentrating mainly on yam production with some little interplanting of cassava and maize. Yam yields per acre are the highest in Nigeria. This sub-region is noted for the large size of its yams grown in mounds three to six feet in height. These often occur in well-watered bottomlands.

In (d) and (e) cereals are so unimportant that these regions represent northern extensions of the roots regions of the woody fallows zone.

II. Woody fallows

1) the western roots-maize region

(i) The south-western cassava-maize region (a). The traditional main crop is maize, but the greater part of the cultivated area is occupied by cassava. Yam and cocoyam have only slight importance. Yam yields per acre are amongst the lowest in Nigeria partly owing to the prevalence of extremely light soils and partly owing to only short fallows. The cassava acreage has increased since the turn of the century with the demand for cheap food in the rapidly growing towns,

[11] See F. R. Irvine on yam cultivation in *A textbook of West African Agriculture*, 1934, pp. 119–134.

[12] P. Bohannan: *Tiv farm and settlement*, 1954, pp. 17 and 48.

especially in Lagos. Moreover, cassava thrives on the light soils. Both early and late varieties of maize are sown making possible two crops in the first year of cultivation. Occasionally yams are interplanted, but egusi melon, cowpeas, cotton, and beans are more common. In the following year cassava is normally planted mixed with some maize, cowpeas, and beans. Food production in this region is markedly commercial in character. In Abeokuta a little upland rice is cultivated in rotation with maize.

(ii) The eastern Yoruba yams-maize-cocoyam region (b). The basis of the cropping system is the interplanting of yams and maize in the first year, sometimes with two maize crops in a single season. As is the normal practice throughout the roots region, yams are planted at the beginning of the rains in February or March with some exceptions in the drier parts of Ekiti Division. Earlier planting often leads to disease. In some cases yams and maize are repeated in the second year. In others cocoyam or, less commonly, cassava follow. Planting generally takes place over two years and then the plots are allowed to revert to fallow with cassava. In this region oil palms established in the secondary vegetation of the fallows provide an important food resource and are allowed to remain on crop land. Planting, however, is rare and immigrants from Benin Province commonly perform the work of harvesting the fruit.

(iii) The Benin yams-maize-cassava region (c). Yams and maize are the traditional staples and cassava has gained in importance during the last 50 years. A common rotation is 1: yams (in most cases using poles to support the vines); 2: maize and cassava or plantains. Cassava remains in the ground during the third year and is picked as required. Maize, egusi melon and peppers are often interplanted as secondary crops with yams. Fallows are usually long (over seven years, and in some cases up to 20 years). Oil palms are abundant and except for those on land under cultivation are held collectively. Plantations of both oil palms and rubber have been established and tree cropping is an important part of normal agricultural activity.

2) The Eastern yam-cassava region (d).

Yams and cassava are normally grown together on newly cleared land. The returns of acreages under each crop per cultivator in Calabar Province (mainly Ibibio) and Owerri and Rivers Provinces (southern Ibo) show equal acreages for the two crops. Yams are planted at the beginning of the rains in February or March and harvested in October to December. Cassava is planted after yams, and harvested throughout the following year when the cultivated land reverts to fallow. A distinctive feature of the well-drained sandier soils of the southern districts is the planting of yams in holes filled with ash and refuse and topped by only low mounds. Maize, cocoyams, beans, and peas are secondary crops of minor importance. Yam yields per acre are high due mainly to careful cultivation techniques. This region is one of the chief producers of palm oil and kernels. Oil palms are widespread on farmland and occur also in dense groves close to or within the settlement units.

3) The delta (e).

Agriculture is less important in the delta than elsewhere. Peoples like the Itsekiri (Jekri) and Ijaw are on the whole more interested in trading and fishing. In the drier areas cassava and maize are the staple crops in the west and cassava and yams in the east. The Urhobo on the northern fringe

of the region are notable yam cultivators and interplant maize, beans, and groundnuts with cassava on plot boundaries. The oil palm grows abundantly and there are a few oil palm plantations. Many people emigrate from the area to harvest oil palm produce in Benin, Ondo and Owerri provinces.

ROTATIONAL PLANTED FALLOW

At present rotational planted fallow cultivation only occurs amongst Ibo and Ibibio cultivators and is not sufficiently widespread or coherent in distribution to represent in Figure 1. The districts concerned are all in the eastern yam-cassava region and in the associated regions of "permanent cultivation." The system of cultivation is similar to that already described. After the final harvest, however, small shrubs with deep taproots are planted. The Ibo of Umuahia and Aba districts plant "echeku" (Acioa barterii) while the Ibibio of neighboring districts plant "nya" (Macrolobium macrophyllum). These quickly form a thick fallow cover. In clearance for cultivation the fallow shrubs are cut down, but the stems are allowed to remain in order to serve as yam stakes. The planting of these shrubs gives the right to crop the area so planted, subject to the community's right to take it for a public purpose.[13]

PERMANENT CULTIVATION

Permanent cultivation is a common feature on compound land, that is the small areas of land, usually near the settlement, devoted to kitchen garden crops and widespread throughout Southern Nigeria. Such land receives household refuse, ashes, and waste, and in a few cases animal manure. In some areas, particularly in Iboland, it is the land used for cesspits. Fertility is often well maintained in consequence and regular cropping without fallow is possible. In most of southern Iboland oil palms and other useful trees are planted on compound land where they eventually form dense groves. Two areas of "permanent cultivation" are marked in Figure 1. In these the main cropland area is either less or no more in area than compound land due to extremely high population densities (Ibibio divisions: Abak 667, Ikot Ekpene 622, Uyo 670; Ibo divisions: Orlu 873, Okigwi 755).[14] Here increase in population total has resulted in the sacrifice of farm land in which use-right is commonly shared in favor of compound land in which use-right belongs to the family or the individual. Production of field crops is often high (*e.g.*, Owerri Province: yams 10,273 lbs. per acre, cassava 11,141 lbs. per acre) and is closely linked with the cultivation of trees.

TREE CULTIVATION

Tree cultivation has already been mentioned in the case of oil palms. There is, however, only one region where tree cultivation is clearly more important than the production of field crops, and that is the cacao belt of the Western Region. Cacao is normally planted in deep heavy loams which have been under forest or under old fallow bush. The plant prefers moisture throughout the year and in consequence rarely thrives outside the woody fallow zone except in well watered valley bottoms. The northern and western regions of the belt were amongst the first portions to be densely occupied by cacao growers and yet the liability of these areas to periods of low relative humidity during the short dry season

[13] The Leverhulme Trust, The West African Commission, 1938–39 (1943), pp. 24–25.

[14] Population census of Nigeria, 1953.

makes them marginal for cacao production. In the southwest soils are too light, with the exception of the shale soils of Ilaro. Yields are diminishing and the formerly flourishing areas around Otta and in the Lagos Colony are now being abandoned or converted to food cropping. During the first five years plantains, bananas, and cocoyams are interplanted to provide shade for the young cacao plants. Kola trees are also interplanted and often shade cacao in the later stages. They provide an alternative commercial crop especially since the introduction of the "nitida" variety from Ashanti which finds a ready market in Hausaland. Oil palms are abundant in the patches of cropland and along the valley bottoms. Coffee has recently become of some importance due to local demand, notably around Ibadan. A large part of the region is under food crops, chiefly maize and yams followed by cassava at the end of the rotation. Cacao and kola plantations are, however, established mainly on the soils considered most suitable for yam cultivation. Food cropping tends to be confined more and more to the sandier soils of the steeper slopes where yams cease to be productive and cassava can still give good returns. The cassava acreage thus appears to be increasing and the crop finds a market in the numerous towns of the region.

FLOOD LAND CULTIVATION

No one region of flood land cultivation can be distinguished. There are only a few narrow strips of suitable valley bottomland and most of these are to be found in the north of Southern Nigeria, chiefly in the valleys of the Niger and Benue. The Nupe make the greatest use of flood land, growing rice, sweet potatoes, cassava, and maize on ridges in small plots. Very little fallowing is needed and some plots are cultivated for ten years or more.[15] In Yoruba and Ibo land there is some cultivation of water yams in large mounds in valley bottoms. In Ibo land flooded or "iyi" land is especially important in the Anambra and Imo valleys and in the Oguta district. During the dry season the "iyi" often carries a crop of cassava.[16] In Badagri and along the banks of the Niger onion beds are watered by handscoops. Outside Nupe the cultivation of swamp rice occurs in very few districts. Attempts have been made to clear and drain mangrove swamps for rice cultivation, but the work is at the moment largely experimental. Floodland cultivation is less common in southern than in northern Nigeria partly because of the occurrence of only a few suitable areas and partly because the longer wet season makes farm work possible for most of the year on the rain lands—the traditional cropping area.

USEFULNESS OF THE SYSTEMS OF CULTIVATION

The usefulness of the systems of cultivation described may be measured by the degree to which they are adapted to the physical environment on the one hand and to economic and social conditions on the other. Floodland and tree cultivation and planted fallow are known elsewhere and even rotational bush fallow and shifting cultivation have had their counterparts in Europe.[17] Each of these systems is adapted to local conditions, but none of the systems in itself represents such an adaptation. The chief features demanding adaptation are:

(1) A resting period for plant growth defined by rainfall and not by tempera-

[15] *A Black Byzantium*, p. 211.

[16] E. Nwogu, unpublished thesis on Owerri District presented at University College, Ibadan.

[17] Morgan, *op. cit.*

ture. In the southern part of the region this resting period is only slight or nonexistent.

(2) The character of local soils and drainage.

(3) The paucity of local equipment and lack of capital for its improvement.

(4) The need for hand tillage and tending of plants, limiting the area which can be planted.

(5) A lack of manures and fertilizers.

(6) The problem in some areas of land shortage.

(7) The paucity until recent years of markets for agricultural produce and the need to depend on local sources for the bulk of domestic requirements.

(8) Local systems of land tenure and local customs with regard to planting, harvesting, and disposal of produce.

The chief methods of adaptation are:

(1) By the choice of crops and of associated rotations, successions, mixtures, and methods of tillage.

(2) By using fallows to rest the land.

(3) By the choice of fallow plants.

(4) By distinctive patterns of agricultural activity according to season (farming calendar).

(5) By distinctive field systems.

Many of these methods in relation to the features demanding adaptation have been described above in the regional treatment. Some further points, however, need to be made with regard to tillage, the farming calendar, and field systems.

Tillage methods are related both to crops and to the physical environment. Broadly, root crops are grown mainly in mounds in areas humid for almost all the year while cereals are grown mainly in ridges in areas with a dry season of three months or more. Ridges are clearly related to the advantage of sowing large quantities of seed in lines. Mounds are related to the advantage of concentrating as much soil as possible around individual large tubers. Both mounds and ridges provide drainage removing excessive quantities of water during downpours. At the same time they conserve moisture near the seed. Large mounds and ridges are constructed where soils are deep and heavy needing drainage, particularly on floodlands. On loams mounds and ridges are smaller, while on sandy soils, as already demonstrated in the case of mounds in Southern Iboland, they become very small and the seed is often planted below ground level. With mounds up to six feet in height and ridges two feet high or more tillage in Southern Nigeria is often deep. The common digging hoe with a blade set approximately at right angles to the handle is used to work the soil normally between three and six inches in depth and to even greater depths where roots are planted in soils needing good drainage. Special hoes are often employed where such deep digging is necessary.

The calendars of farm work clearly reflect rainfall distribution. Comparison is made in Figure 2 between an Owerri Ibo calendar and a Nupe calendar (based on Nwogu for Owerri and Nadel for Bida). In Owerri the longer rainy season combined with the advantage of a short period of less rain between two maxima clearly give a longer cropping period and a more even distribution of work throughout the year. The contrast in times of yam planting reflects the necessity for drying the yam seed before it can sprout. This can be achieved in the ground in Nupe, but only in storage in Owerri. Clearly the Nupe are faced with the problem of a longer period between harvests and therefore the necessity for storage. Owerri's traditional "hunger period" is now of very little significance due to

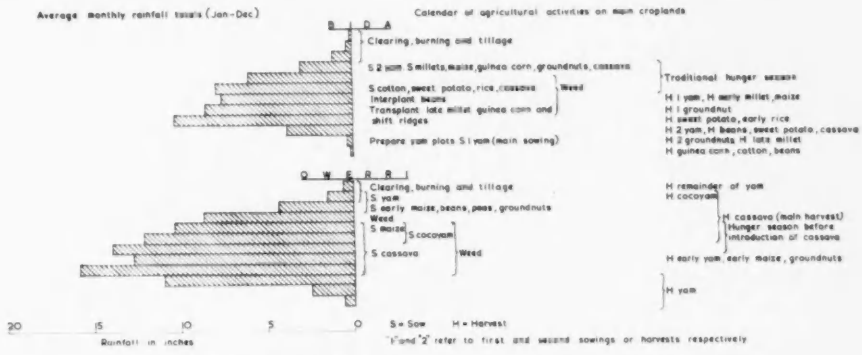
Average monthly rainfall totals (Jan–Dec)
Calendar of agricultural activities on main croplands
Clearing, burning and tillage
S 2 nd. S millets, maize, guinea corn, groundnuts, cassava
S cotton, sweet potato, rice, cassava
Interplant beans
Transplant late millet guinea corn and shift ridges
Weed
Prepare yam plots S 1 yam (main sowing)
Traditional hunger season
H 1 yam, H early millet, maize
H 1 groundnut
H sweet potato, early rice
H 2 yam, H beans, sweet potato, cassava
H 2 groundnuts, H late millet
H guinea corn, cotton, beans
Clearing, burning and tillage
S yam
S early maize, beans, peas, groundnuts
Weed
S maize
S cocoyam
S cassava
Weed
H remainder of yam
H cocoyam
H cassava (main harvest)
Hunger season before introduction of cassava
H early yam, early maize, groundnuts
H yam
20
15
10
5
0
Rainfall in inches
S = Sow H = Harvest
"1" and "2" refer to first and second sowings or harvests respectively

FIG. 2. Calendars of farm work for two localities in Southern Nigeria.

the harvesting of cassava throughout the year since the crop can stay in the ground. In Nupe elaborate storage bins of several kinds are used to ensure a supply of grain at all seasons. In Owerri only the yam rack designed to keep yams dry is of any importance. In the areas with a marked dry season tillage can only be undertaken at the end of the rainy season or immediately after the beginning of the rains. During the dry season loamy or clay soils generally become too hard for working.

Field systems have been discussed elsewhere.[18] Comment should, however, be made here on the tendency to rectangular patterns for convenience in planting rows and subdividing land. Plots and even groupings of plots tend to elongated strip forms mainly due to the problem of access by village paths. Social organization influences land tenure and systems of land division and these in turn influence the field systems. Thus where land is still held by large groups as in Owerri, large blocks of land up to two hundred acres in extent are cleared and then subdivided for cultivation by individual families. Where, however, individual or family use-right in land has replaced community use-right as in many parts of the cacao belt, then the land is worked in a mosaic of scattered patches. The question of tree ownership as opposed to land use-right has created many problems with regard to land holding and working where perennial crops have replaced annuals.

One final point with regard to the adaptation of the systems of cultivation to local conditions is that economic and social circumstances are changing. Methods of adaptation have therefore also had to change. Features of interest here are:

(1) the expansion of perennial crops in response to the development of a market for them;

(2) the expansion of cassava in response to the growth of towns and problems created by short fallows;

(3) the development of commercial cropping of foodstuffs and even of market gardening;

(4) the development of cultivation near roads, railways and markets;

(5) an increase in fruit production partly for export or local canning and partly to satisfy increasing local demands;

(6) a growing demand for improved

[18] W. B. Morgan: "The strip fields of Southern Nigeria," I.G.U. symposium on natural resources, food and population in inter-tropical Africa 1955 (publ. 1956), pp. 33–37.

seed, fertilizers, insecticides, and other means of increasing returns;

(7) a tendency to "fixed" systems of cultivation with a decline in fallow and cropland areas;

(8) the reduction of the cultivation period and often of holding and field sizes.

In this paper an account has been given in effect of the relationship of man to the physical environment in Southern Nigeria by the study of his agricultural techniques. The study of local agriculture provides, however, not only a means of correlating human and physical distributions, but also a basis for studying the problem of improving productivity. As de Schlippe comments . . . "the first step in the right direction is a thorough study of local agriculture. If only we could interpret a traditional practice in terms of its environment and traditional limitations, we could certainly find the way to its improvement. If only we could bring ourselves to think in terms of the local environment instead of in terms of our upbringing, we could certainly bridge the gap."[19]

[19] de Schlippe, *op. cit.*, p. xvi.

THE GEOGRAPHY OF THE CANADIAN IRON AND STEEL INDUSTRY

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A GROWING interest in recent economic development in Canada prompts a study of the geography of the steel industry. The purpose of this paper is to relate the present distribution of the iron and steel industry to resources, markets, and other factors, and to comment on the possibilities of the establishment of new Canadian iron and steel centers in the future.

Canada ranks tenth among steel producing countries of the world, with an output which just exceeded five million tons in 1957. Before World War II, basic steel shapes, such as rods, rails, bars, hot rolled plate, and wire products, dominated the industry. Now, special alloy steels, tin plate, pipe, and cold rolled strip (all sizes) are taking an increasing share of production. The history of the steel industry in Canada has been characterized mainly by a remarkably heavy dependence on American raw materials and by strong governmental support in the form of duties on various iron and steel products, thus affording the industry some protection against American and European producers.[1]

Virtually all of the pig iron and at least 90 per cent of the steel ingots and castings are produced in three widely separated cities in eastern Canada by four large companies: The Dominion Steel and Coal Company of Sydney, Nova Scotia; The Steel Company of Canada and Dominion Foundries of Hamilton, Ontario; and the Algoma Steel Corporation of Sault Ste. Marie, Ontario[2] (see Table I). The remainder of the steel is manufactured from scrap in electric furnaces, mainly at Montreal and Welland in eastern Canada and at Selkirk (just north of Winnipeg), Edmonton, and Vancouver in western Canada. In the United States over 80 per cent of the steel is produced in mills located within the American manufacturing belt, but in Canada only a little over 60 per cent comes from the Canadian manufacturing belt.

Sydney, Nova Scotia

One of the great industrial empires in Canada is that of the Dominion Steel and Coal Company (DOSCO), with executive offices in Montreal, and steel operations in Sydney, Nova Scotia (Fig. 1). As well as coal, iron, and limestone mines, the company owns

[1] The early history of the iron and steel industry of Canada has been the subject of careful study. See W. J. Donald: *The Canadian Iron and Steel Industry*, Boston, 1915; and Donald Eldon: *American Influences in the Canadian Iron and Steel Industry*, Ph.D. Thesis, Harvard University, Cambridge, Mass., 1952.

[2] Until 1957 these companies remained distinctly separate. Early in 1957, the A. V. Roe Company, a large holding company of British origin, and now firmly established in Canada and concerned primarily with the aircraft industry, acquired approximately 11 per cent of the Algoma Steel Company, following the death of Sir James Dunn, President. In the fall of 1957, the A. V. Roe Company made successful overtures to the stockholders of the Dominion Steel and Coal Company and acquired 76 per cent of that company.

TABLE I

COKE OVENS, IRON BLAST FURNACES, AND STEEL FURNACES OF THE BASIC STEEL PRODUCERS IN CANADA AS OF JANUARY, 1957[1]

	ALGOMA (*Sault Ste. Marie*)	*DOFASCO* (*Hamilton*)	*DOSCO* (*Sydney*)	*STELCO* (*Hamilton*)	*Total*
Coke ovens					
Number	251	60	114	191	616
Capacity, thousands of net tons	1,340	400	675	1,151	3,566
Iron blast furnaces					
Number	7[2]	2	3	4	16
Capacity, thousands of net tons	1,553[2]	656	680	1,241	4,130
Open-hearth steel furnaces					
Number	14	2	6	13	35
Capacity, thousands of net tons	1,120	100	820	2,040	4,080
Electric steel furnaces					
Number	.....	5	4[3]	1	10
Capacity, thousands of net tons	.....	185	116[3]	110	411
Oxygen steel furnaces					
Number	.....	2[4]	...	.....	2
Capacity, thousands of net tons	.....	365	...	.....	365
Total steel furnace capacity, thousands of net tons	1,120	650	936	2,150	4,856

[1] Equipment considered obsolete, or not in use for some other reason, not included.
[2] Including two blast furnaces at the Port Colborne Ontario subsidiary plant, annual capacity 273,000 net tons.
[3] Includes two electric furnaces at the Montreal subsidiary plant, annual capacity 82,800 net tons.
[4] A third oxygen vessel now being installed.
Source: L. Morgan: *The Canadian Primary Iron and Steel Industry*, a special study for the Royal Commission on Canada's Economic Prospects, Ottawa, 1956, p. 71 (revised and brought up-to-date).

ships, shipyards, and numerous steel fabricating mills, and employs a total of over 30,000.

During the nineteenth century, several companies began smelting iron ore near the coal fields of eastern Cape Breton Island. Gradually they amalgamated and the present company was formed in 1928. Serious economic conditions in the 1930's necessitated financial reorganization, but in the last decade a great demand for steel has permitted a relatively high production, encouraging the modernization of many of the facilities.

Assembly costs of raw materials at Sydney are not available, but undoubtedly they are lower than at other mills in Canada. Coal comes from company-owned pits only a few miles from the mill. Recent modernization of equipment and mining methods has brought about a more efficient production than heretofore, with a corresponding reduction in cost. Even so, production per man is still far below that in the coal fields of Pennsylvania and West Virginia. Furthermore, Cape Breton coal contains a relatively high percentage of sulphur (just over two per cent) and is very volatile, and consequently makes coke inferior to that manufactured from American coal at Hamilton and Sault Ste. Marie. It is neither strong enough nor low enough in sulphur to be classified as prime furnace fuel.[3]

Company ships transport iron ore from company-owned mines on Bell Island off the east coast of Newfoundland. The Dominion Wabana Ore Company, a subsidiary of DOSCO, produced 2,600,000 tons in 1956 of which over 80 per cent was exported to the United Kingdom, Germany, and other European countries. The ore contains more silica and phosphorous than is desirable for the open hearth furnaces

[3] *The Steel Industry of Nova Scotia:* Report No. 11, by the Arthur McKee Company to the Royal Commission on Provincial Development and Rehabilitation of Nova Scotia, Halifax, 1944, p. 47.

FIG. 1. Location of primary iron and steel mills and iron mines in eastern Canada.

at Sydney, but it is ideal for most European operations. Small amounts of iron ore from Labrador and Brazil are mixed with Wabana ore at Sydney. Limestone is shipped from Aguathuna on the west coast of Newfoundland. This favorable proximity of raw materials is offset by the drawback of the poor physical quality of the coke and the high phosphorous and silica content of the iron ore. These difficulties make steel manufacturing costs somewhat higher than at Ontario mills.[4]

At first it was hoped that the production of iron and steel would attract secondary industries to Nova Scotia, but when these hopes failed to materialize, the steel companies, in the early years of this century, began to specialize in the production of rails to meet the rising demand from the expansion of Canadian railways, especially in the Prairie Provinces. Following World War I, the demand for steel rails fell off greatly and other markets were difficult to develop. Subsidiary plants, especially in the St. Lawrence Lowlands, such as Graham Nail and Wire in Toronto, Canadian Tube and Steel Products in Montreal, and Canadian Bridge in Windsor, Ontario, were gradually acquired, and today absorb a great deal of the production. The handicap of high freight charges is thereby partially overcome by shipping blooms, billets, and wire rods to fabricating mills in southern Ontario and Quebec for further processing. For example, in 1955 freight charges on finished nails from Sydney to Montreal were $13.00 per ton, to Toronto $20.40 per ton, and to Windsor $23.20 per ton; but costs for shipment of unfinished wire rod from which nails are manu-

[4] L. Morgan: *The Canadian Primary Iron and Steel Industry*, a special study for the Royal Commission on Canada's Economic Prospects. Ottawa, 1956, pp. 16–17.

factured were respectively $7.61, $10.26, $11.32 per ton.[5]

Subsidiaries in the Maritime Provinces such as the Halifax Shipyards and Trenton Steelworks (railway cars, wheels, and axles) normally take less than 20 per cent of the steel production at Sydney. The mill is admirably located to export steel, but relatively high costs of production and, to some extent, the lack of facilities for manufacturing a greater variety of products, restricts overseas trade. Large orders such as the recent purchase of 25 million dollars worth of rails by Mexico are very exceptional.

DOSCO is the only Canadian company east of Manitoba which as yet produces no flat rolled steel. Rails are still all-important and make up 40 per cent of the total production, and recent reconstruction has made the rail-finishing mill at Sydney one of the most efficient, if not the most efficient, on the continent.[6]

DOSCO's share in total Canadian shipments of steel has dropped from over 17 per cent in 1951 to less than 10 per cent in 1955. Distance from the market, poor quality coking coal, and the general lack of local supplies of scrap are serious disadvantages, and are only partially offset by low cost iron ore, specialization in certain products (rails), subsidiaries, cheap ocean transport for the export of steel and shipment to Vancouver, and fully integrated operations. Undoubtedly, the persistence of production in such a marginal location illustrates the law of inertia,[7] for today it would be deemed uneconomic to build a steel mill so far from the main market.[8]

[5] *The Toronto Globe and Mail*, October 22, 1955, p. 8.

[6] L. Morgan: *op. cit.*, p. 11.

[7] Allan Rodgers: "Industrial Inertia—A Major Factor in the Location of the Iron and Steel Industry in the United States," *Geogr. Rev.*, Vol. 42, 1952, pp. 56–66.

HAMILTON

Hamilton is the most important steel center in Canada and resembles American Great Lakes cities such as Buffalo and Cleveland that lie midway between the coal and iron mines and close to the market. Over 90 per cent of the iron ore comes from Upper Minnesota and Michigan in ore carriers via the Great Lakes, and is landed at the docks of the steel companies on Hamilton Harbor. Coking coal comes from Pennsylvania and West Virginia via Lake Erie Ports and the Welland Canal. Limestone is quarried near by. Scrap is collected in the industrial towns of southwestern Ontario, but is also brought in from the United States, depending on price and supply.

Demand for steel is very high in the vicinity of Hamilton where most of Canada's automobiles, farm machines, domestic appliances, and electrical goods are manufactured. It is estimated that at least 60 per cent of production is sold south of a line from Oshawa to Sarnia, another 20 per cent is shipped to the Province of Quebec, mainly to Montreal, and the remaining 20 per cent is divided between other parts of Ontario and the West. Shipments to the Maritimes and overseas are insignificant.

The first blast furnace was built in Hamilton in 1895, mainly because o tax concessions offered the company by the city. Two years later a steel mill was constructed. Modern expansion at Hamilton may be dated from 1910 when the Steel Company of Canada (STELCO) was formed from the amalgamation of five small Ontario companies. It has grown to be the largest steel company in Canada, accounting for over 50 per cent of the

[8] Walter Isard: "Some Locational Factors in the Iron and Steel Industry since the Early Nineteenth Century," *Journ. of Polit. Econ.*, Vol. 56, 1948, pp. 203–217.

total Canadian shipments in steel in 1955.

STELCO owns, outright or in part, coal mines at Coalwood in West Virginia and Hillsboro and Mather in Pennsylvania and iron mines in the Mesabi, Gogebic, Menominee, and Marquette areas of Minnesota and Michigan. The company has invested large sums in the taconite process, and, for example, owns 10 per cent of the Erie Mining Company which is producing each year 7,500,000 tons of high-grade taconite pellets from its plant near Aurora, Minnesota. In recent years the diminishing reserves of Lake Superior ores have caused the company to take up several options on iron ore fields in Labrador, Quebec, and northern Ontario. In particular, it shares half interest with the Bristol Quebec Mining Company in Hilton Mines near Bristol, Quebec, where low-grade ore is being concentrated into pellets.[9] Production is expected to reach 650,000 tons in 1958 and remain fairly constant at that level over the next few years. Undoubtedly, in the future the share of Canadian ore used by STELCO will increase but the change will be gradual.

Enjoying the same advantages of location on Hamilton Harbor is the plant of the Dominion Foundries and Steel Company (DOFASCO). Rate of growth in recent years has been the highest of any steel company, the share of its Canadian shipments of steel rising from 9.5 per cent in 1951 to 14.0 per cent in 1955. It was founded in 1917 but did not become a fully integrated mill until 1951 when the first blast furnace was built. Unlike the other large companies in Canada, DOFASCO owns neither coal nor iron mines, and must buy raw materials on the open market. Most of its iron ore comes in by lake vessels from the Lake Superior region of the United States, and coking coal is imported from West Virginia and Pennsylvania.

In late 1954, DOFASCO introduced the new Brassert oxygen method of producing steel, and by 1957 the oxygen furnaces were producing about 2000 tons of steel daily.[10] The old open-hearth method is gradually being discontinued but it is unlikely that this technical change will have any effect on the distribution of steel mills in Canada. The main change arises from the use in the new process of 80 per cent pig iron and 20 per cent scrap which has caused an expansion of pig iron production at DOFASCO, in turn causing a large import of ore and a lesser demand for scrap.

The Hamilton mills differ mainly from the two other principal companies in Canada by manufacturing a much greater variety of steel products and by operating more successfully during periods of economic depression, a reflection of their superior location in the heart of the Canadian market. All of the Canadian production of such items as tin plate, cold rolled strip, and galvanized sheet comes from Hamilton, but, on the other hand, none of the rails or rail fastenings.

Just to the east of Hamilton at Welland, Ontario, high-speed steels, tool steels, and high-quality stainless steels are manufactured by the Atlas Steel Company. High-quality alloy steel is produced in electric furnaces from scrap. Production varies from 1 to 2 per cent of the Canadian total, but value

[9] The Bristol Quebec Mining Company is owned jointly by the Pickands and Mather Company and Jones and Laughlin Steel Corporation. The share accruing to Pickands and Mather will move in large part to the Inter-Lake Iron Company.

[10] By 1957 no other companies in the United States and Canada had taken advantage of this important technical development, but several, including the McClouth Steel Company of Detroit, have obtained licenses from Brassert Oxygen Technique A. G. of Zurich, Switzerland, to begin operations.

of production is relatively high. A few miles to the south at Port Colborne, the Canadian Furnace Company, a subsidiary of the Algoma Steel Corporation, produces approximately 250,000 tons of pig iron each year in two blast furnaces.

SAULT STE. MARIE

Just to the northwest of the Canadian Manufacturing Belt at Sault Ste. Marie is located the large iron and steel works of the Algoma Steel Corporation (ALGOMA). Its location on the Upper Lakes recalls that of the mill at Duluth, but in recent years it seems to have enjoyed a greater prosperity. Like DOSCO of Sydney, Nova Scotia, the ALGOMA mill is marginal to the main Canadian market and this has caused it, whenever possible, to specialize along lines which do not compete with the Hamilton producers. At present the mill at Sault Ste. Marie is the second most important in Canada. Production of coke is unusually high (1.34 million tons) because of a contract to supply the International Nickel Company's smelter at Sudbury.

Why a steel industry started at Sault Ste. Marie around the turn of the century can only be explained as a result of personal initiative.[11] In the 1890's Francis Clergue, representing several American investors, became interested in the possibilities of developing electric power on the St. Mary's River. Because of his influence, a pulp mill and a ferro-nickel plant were built to use the power. When, later, a body of iron ore was discovered at Michipicoten, 120 miles to the north, it further stimulated the ferro-nickel industry and led to the building of a steel mill in 1902. The demand for rails on the Prairies encouraged immediate expansion. In 1909 limestone mines at Fiborn, Michigan, and coal mines in West Virginia were purchased and these are still controlled by the Company. As the hematite deposits at Michipicoten diminished, ore was imported in increasing quantities across Lake Superior from Minnesota. In 1921 the Canadian mines closed down and the mill became entirely dependent on American raw materials until the outbreak of World War II.

In 1939 the ore bodies at Michipicoten were reappraised and, because the Province of Ontario had for many years agreed to pay a bounty on domestic production, the Company decided to develop the low-grade siderite deposits. Two mines, containing ore with a 35 per cent iron content but a very significant 3 per cent manganese content, were brought into operation and a sintering plant was built for beneficiating the ore. Production averages 1,500,000 tons annually of which 70 per cent is shipped to the United States. Because of the relatively high manganese content the sinter must be mixed with other ores before it can be charged into the blast furnace, and, consequently, only 30 per cent of the production can be consumed at Sault Ste. Marie. Furthermore, because of its favorable chemical composition and excellent structure, the sinter commands a high price in the United States market and the Company profits from its export. In turn, cheaper American ores are substituted in the blast furnace operations at Sault Ste. Marie.

Scrap is difficult to find in the immediate area. Some is purchased in Michigan and Wisconsin, but most of it comes from the railroads to the west and the International Nickel Company. In recent years more efficient pig iron production has reduced the need for scrap.

At first, rails and rail fastenings accounted for most of the production from

[11] L. L. Prior: *Sault Ste. Marie and the Algoma Steel Corporation*, unpublished M. A. Thesis, Department of Geography, University of Toronto, 1956, pp. 24–29.

the mill, and even today these products make up 30 per cent of the total production. Sales to American foundries of merchant pig iron amount to over 200,000 tons annually. Costs of manufacturing pig iron must be comparable to or even lower than those of American producers in the Lower Lakes region or else ALGOMA could not compete in the United States. In recent years the mill has increased its production of items which are, for the most part, not manufactured at Hamilton, and consequently its steel products can be sold in southern Ontario and Quebec with a minimum of competition from Hamilton producers. Furthermore, the Company continues to ship more steel by water which helps to offset the disadvantages of relatively high rail charges to the industrial belt. Over $100,000,000 has been spent by the Algoma Steel Company in the last few years to modernize equipment and to make possible the production of a larger number of special steel goods. The Mannesmann Tube Company recently opened a plant at Sault Ste. Marie which will use at least 225,000 tons of steel annually, and as such has become the first large consumer to locate near the mill.

RESOURCES

Heavy dependence on American raw materials is a striking feature of the Canadian iron and steel industry. Only the Sydney mill uses Canadian coal and high transportation costs make it unlikely that either Nova Scotia or Alberta coal will ever be used in the Ontario mills. Similarly, the large Canadian deposits of iron ore have so far been too inaccessible to exploit, causing the industry to depend heavily on supplies from the United States which can be imported easily and cheaply. Mines in the Lake Superior region of the United States have fed the furnaces at Hamilton and Sault Ste. Marie for over half a century. In the future, Canadian producers of steel will use an increasing amount of domestic iron ore, but the change will be gradual. High-grade deposits in the Lake Superior region of the United States are dwindling, but low-grade iron ore in that area will be mined for many years to come and in the concentrated form of iron pellets will be shipped to steel mills in Canada as well as the United States.

The direction of ore shipments depends not only on transportation costs, but also on ownership of mines and the nature of the iron ore. For example, the iron ore deposits most accessible to Hamilton are near Marmora, Ontario, about 120 miles to the northeast. Almost 300,000 tons are produced there annually, but, because it is owned and developed by the Bethlehem Steel Company, all of it goes to the Lackawana steel mills at Buffalo (see Table II). On the other hand, over 750,000 tons of iron pellets move from the Erie Mining Company in Upper Minnesota to STELCO in Hamilton. Virtually all iron ore mined at Steep Rock in northwestern Ontario goes to the United States, and it seems likely that it will continue to do so.

Furthermore, iron ore varies greatly in chemical composition and content. Most mills must mix ore, often from widely different sources. It has already been indicated that the Algoma Steel Corporation cannot use all of the Michipicoten ore because of its manganese content and at least 70 per cent of the production is sold to the United States.

The probable influence of new iron ore developments in Labrador and Quebec on the Canadian steel industry

can be debated.[12] So far only the Iron Ore Company of Canada is actually engaged in mining ore, although other companies such as Canadian Javelin and Cartier Mining Company have leases and will undoubtedly begin operations soon. The deposits lie in the Labrador trough, straddling the Quebec-Newfoundland boundary (Fig. 1). A railway has been built from Sept Iles on the Gulf of St. Lawrence to Schefferville, 360 miles farther north. Production has increased steadily and in 1956 over 12,000,000 tons of iron ore were shipped out from Sept Iles.

According to the financial arrangements at least 61 per cent of the production will go to five American steel companies—Republic, National, Youngstown Sheet and Tube, Armco, and Wheeling Steel Company. The remaining 39 per cent will be sold on the open market by three companies—Hollinger North Shore Explorations, Labrador Mining and Explorations, and Hanna Coal and Ore—the last of these handling 23 per cent of the total production. Much of the so-called open-market ore has already been assigned to steel mills in the United States under long-term contract. For example, the Bethlehem Steel Company has a contract with the Hanna Coal and Ore Company to receive 30,000,000 tons within the next 20 years.[13] Thus the actual amount of ore sold on the open market may be relatively small. Companies like DOFASCO in Hamilton may find it impossible to get all they require and so have to continue to buy Minnesota ore for some time.

Costs of shipping open-market iron ore in 1957 from Schefferville to the Lower Lakes were higher than from Mesabi to the Lower Lakes. It cost approximately $6.40 to ship a ton of

[12] Reconnaissance diamond drilling has outlined large reserves of iron ore west of Ungava Bay in far northern Quebec. But it is very likely that most of this ore will be exported after the area is developed and consequently will have no effect on the Canadian steel industry.

[13] *Basic Iron and Steel Products*, Reference No. 118, The Tariff Board, Dept. of Finance, Queen's Printer, Ottawa, 1957, p. 64.

TABLE II

IRON ORE PRODUCTION IN CANADA BY COMPANY AND PROPERTY 1956

Company	*Property location*	*Material shipped*	*Production in long tons*	*Shipments*
1. Dominion Wabana Ore Limited	Wabana, Nfd.	beneficiated hematite	2,654,219	Sydney N. S. 18%, U. K. 38%, W. Germany 39%, Others 5%
2. Iron Ore Co. of Canada	Schefferville, P. Q.	direct-shipping ore	12,023,000	U. S. 79%, U. K. 12%, Canada 6%, W. Europe 3%
3. Marmoraton Mining Co. Ltd.	Marmora, Ont.	iron ore pellets	283,220	U. S. 100%
4. Algoma Ore Properties Limited	Michipicoten, Ont.	iron sinter from siderite	1,411,427	U. S. 70%, Sault Ste. Marie, Ont. 30%
5. Steep Rock Iron Mines Ltd.	Steep Rock Lake, Ont.	direct-shipping ore	3,316,126	U. S. 99%, Canada 1%
6. Argonaut Mine Div. of Utah Co. of the Americas	Quinsam Lake, Vancouver Isl., B. C.	magnetite concentrates	183,837	Mainly Japan
7. Texada Mines Ltd.	Texada Island, B. C.	magnetite concentrate	146,480	Mainly Japan
8. OTHERS	.....	.....	94,469	.....
Total	.....	.....	20,112,778	.....

Source: J. H. Janes: *A Survey of the Iron Ore Industry in Canada During 1956*, Mineral Resources Information Circular M.R. 22, Canada Dept. of Mines & Technical Surveys, 1957, p. 10, with slight modifications.

ore from Schefferville to Cleveland compared with $3.11 from Mesabi to Cleveland.[14] Open-market ore is purchased F.O.B. Sept Iles and to this price is added the transportation charge. In 1956 the Iron Ore Company of Canada negotiated a contract with shipping firms which will last for eight years to fix an over-all price for iron ore at Lake Erie ports to be competitive with ore from the Lake Superior region.[15] Costs of mining ore in the Labrador region are extremely low. However, even with the advantage of the St. Lawrence Seaway after 1959, over-all costs to the consuming mills in the Lower Lakes area may not be any lower than the average laid down costs of underground Minnesota ore.[16] It may be that, for the various reasons stated, open-market ore used at Hamilton will continue to come from American mines in the Superior region.

To sum up, of the 20,112,778 tons of iron ore produced in Canada in 1956, only 1,528,000 tons were used in Canada, 14,000,000 tons were exported to the United States and the remainder was exported to Western Europe. What is very interesting is the exchange of iron ore across the United States–Canadian border via the Great Lakes. Steel mills in Ontario import approximately 5,000,000 tons of iron ore each year from the United States and in turn about 5,000,000 tons of iron ore are exported from Ontario mines to the United States.

[14] The shipment from Schefferville to the Lower Lakes is made up as follows: rail freight from Schefferville to Sept Iles, $3.00 a ton; water rate from Sept Iles to Contrecoeur, 75c; transfer charge at Contrecoeur, 75c; water rate from Contrecoeur to Lake Erie Ports, $1.66; unloading charge at Lake Erie Ports, 24c. Source: *Ibid.*, p. 73.

[15] *Loc. cit.*

[16] *Loc. cit.*

MARKETS AND FREIGHT RATES

Canada's production of steel has increased greatly in the last decade, but consumption of unfabricated steel exceeds production by over a million tons annually.[17] In certain parts of Canada such as the Far West and the Windsor area of Ontario, foreign companies can undersell domestic producers on many steel products. Furthermore, Canadian companies do not manufacture certain types of steel and various rolling mill products have to be imported each year.

Table III shows the regional variations of production and consumption

[17] L. Morgan, *op. cit.*, p. 5. (See also discussion of per capita consumption in the United States and Canada.)

TABLE III

PRODUCTION AND APPARENT CONSUMPTION* OF STEEL INGOTS IN CANADA IN 1953

(net tons)

	Atlantic Provinces	*Quebec*	*Ontario*	*Prairie*** *Provinces*	*British Columbia*	*Canada*
Production	638,114	97,020	3,263,427	77,082	39,826	4,115,469
Consumption	250,100	1,385,300	3,090,400	308,100	234,000	5,267,900
Surplus + Deficiency −	+388,014	1,288,280	+173,027	−231,018	194,174	−1,152,431

*Rolling mill products have been converted to ingot equivalent at a 75 per cent loss ratio.

**Production in Alberta has increased since 1953 with the building of a mill at Edmonton where capacity is 100,000 tons of steel ingots anually.

Sources: Dominion Bureau of Statistics publication on Primary Iron and Steel in Canada and Economics Branch, Department of Trade and Commerce, Ottawa.

TABLE IV

FREIGHT CHARGES TO CHIEF CANADIAN STEEL MARKETS, MARCH 1, 1956

(cents per 100 lbs.)

BARS

Destination	*Points of shipment*								
	Sydney N. S.	*Hamilton*	*Sault Ste. Marie*	*Buffalo*	*Detroit*	*Chicago*	*Geneva Utah*	*U. K. Ports*	*European Ports*
Halifax	26	100(*100)S	.....	130(*40)	..	...	...	69	62
Quebec City	50	72.5	93.5	97	..	...	...	...	...
	...	64.5 S	.....	.....	..	...	...	...	...
Montreal	59	35(*100)B	61 B	76(*100)S	..	...	...	69	62
	...	37(*100)S	66	82(* 23)	..	...	...	...	...
	...	45(* 60)	.....	.....	..	...	...	...	...
Toronto	...	13	50B	43(* 40)	59	91	...	122	121
St. Catharines	100	15	57	34	57	91	...	...	...
Windsor	121	29(* 30)	50 B	45.1(*80)	14	...	...	...	...
	...	.....	70	64 (*32)	..	...	...	...	...
Winnipeg	...	158.5[1]	140[1]	.....	..	142	217	263[2]	257[2]
Regina	...	212.5[1]	198	.....	..	183	250	242[2]	236[2]
	...	220 S	.....	.....	..	...	...	...	...
	...	243	.....	.....	..	...	...	...	...
Calgary	...	227.5(*100)[1]	227.5[1]	.....	..	212	169	211[3]	221[3]
	...	235 (*100)	235	.....	..	...	...	...	...
Vancouver	...	110	110	.....	..	152	94	90	100

*Minimum carload lot in thousands of pounds. B, boat rate. S, summer rate.
[1] Water and rail (during navigation season). [2] Via Churchill. [3] Via Vancouver.
Source: *Basic Iron and Steel Products*, Reference No. 118, The Tariff Board, Queen's Printer, Ottawa, 1957, p. 280.

of steel ingots in Canada, and attempts somewhat crudely to illustrate local degrees of surplus and deficiency. Even in Ontario, where there is a small surplus, certain types of steel are brought in from the United States and Europe. Shipments are made from Nova Scotia and Ontario to Quebec to partially offset the large deficit of over a million tons. The main market for steel in Canada is in Ontario and Quebec where almost 85 per cent of the steel is consumed, more particularly in the manufacturing belt extending from Windsor to Quebec City.

The Hamilton producers are best located to take advantage of this lucrative market, having much lower freight charges than the other two main centers (see Table IV).[18] At a point midway between Quebec City and Montreal, Hamilton's advantage disappears and Sydney steel becomes competitive. No American or European mills have freight rate advantages in the large Montreal market. In eastern Canada on most products on the basis of freight rates, Sault Ste. Marie becomes competitive with Sydney just west of Montreal, but rates on steel rails are approximately the same in the Toronto area with Sault Ste. Marie having an advantage in the Niagara Peninsula and southwestern Ontario (see Table V).[19] On almost all steel products Hamilton has the lowest freight rates in southern Ontario with the exception of the Windsor area where Detroit producers can deliver steel at lower rates (see Table IV).

Freight rates give Sault Ste. Marie a slight advantage over Hamilton in western Canada, especially in Manitoba and Saskatchewan, but in Alberta and British Columbia rates are identical on most steel products. A combination of agreed charges between the steel com-

[18] Note that the table applies only to steel bars. There are occasional variations in freight charges on other products but generally rates on steel bars are typical.

[19] Hamilton mills do not produce steel rails.

TABLE V

FREIGHT CHARGES TO CHIEF CANADIAN STEEL MARKETS, MARCH 1, 1956

(cents per 100 lbs.)

RAILS

Destination	*Points of shipment*				
	Sydney N. S.	*Sault Ste. Marie*	*Buffalo*	*U. K. Ports*	*European Ports*
Montreal	39.8	47.8	63.2	77.7	72.4
Toronto	54.0	54.8	36.7	.....	.....
Hamilton	57.5	54.8	35.2	120.1	118.9
Niagara Falls	62.8	56.6	27.9	.....	.....
North Bay	70.8	45.9	78.0	.....	.....
Vancouver	111.6*	123.0	175.1	90.0	92.0

*Via Panama.
Source: *Basic Iron and Steel Products*, Reference No. 118, The Tariff Board, Queen's Printer, Ottawa, 1957, p. 281.

panies and the railways and potential water competition via the Panama Canal makes rail rates lower on steel from eastern Canada to Vancouver than to most Prairie cities. In the western Prairies and British Columbia some American mills have small advantages in freight rates over Canadian producers. Rates from Chicago are lower to southern Saskatchewan and southern Alberta than those from Sault Ste. Marie and Hamilton. Steel producers at Geneva, Utah, Fontana, California, and in the United Kingdom and Western Europe enjoy lower rates to Vancouver than Ontario mills. However, in Canada the selling price of foreign steel may not necessarily be lower than domestic because of duties imposed on imported steel.

In summary, Sydney has advantages over domestic competitors in the Atlantic Provinces and about as far west as Trois Rivières on most products and as far west as Toronto on steel rails. Hamilton enjoys advantages over all competitors, both domestic and foreign in that part of the manufacturing belt between Trois Rivières and Chatham, Ontario, Detroit having lower rates in southwestern Ontario. Sault Ste. Marie has a slight advantage in Manitoba and eastern Saskatchewan, but American and European mills have lower rates on many products in Alberta and British Columbia.

FUTURE DEVELOPMENT

Many Canadians would like to see a fully integrated primary iron and steel industry established in western Canada. Most enthusiastic of these are certain groups in British Columbia, but demand in the West, although growing, still remains relatively small. In British Columbia less than 300,000 tons are used each year which is only 5 per cent of the Canadian consumption. The relevant figures for 1953 are given in Table III and from them it has been concluded that the British Columbia market is not large enough to support even the smallest blast furnace of economic size.[20]

At present the Western Canada Steel Company of Vancouver can produce 40,000 tons of steel ingots annually, but their rolling mills require almost 100,000 tons, a discrepancy of about 60,000 tons. Recently, this company transferred its works to a site on the Fraser River in south Vancouver where it plans to build

[20] *Some Aspects of the Canadian Iron and Steel Industry with Particular Reference to British Columbia*, British Columbia Research Council Publication, Vancouver, 1954, p. 2.

a steel ingot plant with a capacity of 100,000 tons to which, within five years, will be added an electric smelter to treat iron ore. Full development will require not only a larger market but also an accessible body of iron ore containing not less than 25,000,000 tons. Contrary to the opinions of many, the iron mines now operating at Quinsan Lake and Texada Island in coastal British Columbia are not very productive and will continue to decline in the future because of diminishing reserves. All of the iron ore which is, at present, mined, is exported to Japan.

From time to time, speculation has heightened concerning the use of almost 13 million tons of iron in the form of "iron tailings" accumulated over the years at Kimberley, British Columbia, from the mining of lead and zinc at the Sullivan Mine. Coke is manufactured at Michel about 100 miles by rail to the east, and the Consolidated Mining and Smelting Company, owners of the deposits, have developed low cost electric power in the area. Furthermore, Kimberley lies almost half way between the main markets on the Coast and in Alberta. In many ways, because of local raw materials and low cost power and its position with respect to the markets, Kimberley has the best conditions in the West for a pig iron and steel industry. All that is required is a larger market.[21]

The discovery and development of oil and gas resources in Alberta during the last ten years has created a need for an increasing amount of steel. In response to this expansion, the Premier Steel Company of Edmonton began to make steel from scrap in electric furnaces in 1954 and by 1957 capacity had reached 90,000 tons a year. This company holds leases on a large body of iron ore in northwestern Alberta near Hines Creek in the Peace River Country and has publicized its desire to exploit them. Coal is known to occur in the area but the precise location of various types is uncertain. The development of an iron and steel industry at the ore fields seems very unlikely. Not only would it be running counter to the basic economics of location of steel plants in North America, but it would be postulating a demand which as yet does not exist. At present, Alberta accounts for only three per cent of the steel consumption in Canada.

Near the eastern end of the Crows Nest Pass in Alberta, Western Canada Collieries and Western Canada Petroleums in conjunction with a group of French interests are investigating the possibilities of building a smelter to process local low-grade iron ore, using coking coal also found close by. Again, the relatively small market and the already successful production of steel from scrap in the West make an early start in production unlikely.

Saskatchewan and Manitoba have shown less interest in an iron and steel industry probably because the market is relatively small and supplies can be easily obtained from Ontario mills. A mill using scrap with a capacity of about 100,000 tons a year has operated successfully at Selkirk, Manitoba (just north of Winnipeg), for many years.

The discovery and development of large bodies of iron ore in Quebec and Labrador has increased the speculation on the inauguration of a primary iron and steel industry in the Province of Quebec. Sept Iles, the rail terminus on the St. Lawrence River of the iron ore mines of central Quebec, seems to many to be an ideal location. To be

[21] The type of pig iron furnace considered in the Report on the Steel Industry in British Columbia made to the British Columbia Research Council was the standard Tysland-Hole electric unit of 13,200 KVA capacity producing about 40,000 tons of iron a year. For a description see *ibid.*, pp. 64–74.

sure, raw materials could be assembled cheaply, but distance from the market would mean high transportation costs and thus reduce its attractiveness.

What seems to be most likely is the establishment in the near future of a fully integrated iron and steel mill on the St. Lawrence River near Montreal.[22] Even today iron ore is being landed at Contrecoeur near Montreal from Sept Iles for transhipment on the smaller vessels built to navigate the present St. Lawrence canals. Coking coal could be brought in from either Nova Scotia or Pennsylvania or West Virginia by water. Scrap accumulates in the Montreal area and of considerable advantage would be the ingot iron which comes as a by-product from the Quebec Iron and Titanium Corporation at Sorel. It is very much like high-quality scrap and can be charged into open hearth furnaces. Present production averages about 200,000 tons annually. A steel mill located on the St. Lawrence River near Montreal could take advantage of a large and growing market and could assemble raw materials fairly cheaply and have plenty of fresh water for cooling purposes.

CONCLUSION

In conclusion, the distribution of steel production in Canada demonstrates a few basic principles. Hamilton has an excellent location with a full market orientation. Being on Lake Ontario, the Hamilton mills can assemble raw materials cheaply and draw upon an unlimited supply of cold water. Sydney is very much off center and Sault Ste. Marie less so. Both locations illustrate the fundamental law of inertia in the steel industry. The tendency is for a mill, once established, to continue production long after the location has ceased to be economic. Because of governmental concern over the economic problems of the Atlantic Provinces it is unlikely that the Sydney mill which has the poorest location of any in North America will ever be closed. The economy of Nova Scotia would suffer greatly by the loss of its chief manufacturing industry.

Resources have played a subsidiary role in the location of the Canadian steel industry and it is unlikely that the rapidly growing iron ore industry in Canada will exert any significant influence on the choice of new centers. Montreal, which is the most probable site of a new mill, is attractive mainly because of accessible markets and excellent transportation facilities. At least many years will pass before western Canada will be able to support a fully integrated iron and steel mill of economic size.

[22] L. Morgan: *op. cit.*, p. 49.

THE AACHEN COAL FIELD

Alan Harris and Wilhelm Matzat

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THE collieries of the Aachen district of Germany lie close to the Dutch frontier and exploit the same major coal basin as the mines in Dutch Limburg. With one exception they lie between the frontier and the river Inde, a left-bank tributary of the Rur, which joins the Maas at Roermond (Fig. 1). The principal features of the Dutch coal field have been described elsewhere.[1] In this article the more important aspects of the economic geography of the Aachen coal field will be discussed.

Structure and Geology

The Upper Carboniferous rocks of South Limburg continue below the frontier into Germany. In the Netherlands the coal-bearing strata are concealed by post-Carboniferous and superficial deposits. The same is true of the greater part of the German coal field; but in two areas Coal Measures are exposed. In the west they outcrop in a narrow belt along both sides of the river Wurm, from the neighborhood of Würselen northwards to beyond Kohlscheid, and in the east in a larger area along the Inde and Vicht valleys above Eschweiler.

These outcrops form part of two complex basins, known as the Wurm and Inde basins. The major axes of these run from northeast to southwest, and between them lies an anticline—the Aachen anticline—along which pre-Carboniferous rocks now appear at the surface in the vicinity of Aachen.

Both basins are traversed by major faults, which have divided them into a series of blocks. Due to the displacements that have occurred along the faults the top of the Upper Carboniferous succession lies at different depths below the surface in the various parts of the coal field. Generally speaking, the post-Carboniferous cover thickens towards the northwest and east in the Wurm basin and towards the east in the Inde basin. Although this cover does not exceed 500 or 600 feet in thickness over much of the western Wurm basin, it increases in thickness considerably east of the Sandgewand fault (Fig. 2). In the Rurgraben, still farther east, the Upper Carboniferous rocks lie buried below 2000 to 3000 feet of later sediments and are largely beyond workable depth. Beyond the graben, however, coals occur at workable depths in the Erkelenz district, on the upthrow side of the eastern graben faults. Here the seams are won from Sophia Jacoba colliery. This colliery lies at some distance from the main mining area, and partially bridges the gap between the coal fields of Aachen and the Ruhr (Fig. 1).

The post-Carboniferous cover varies in age from Secondary to Recent. Perhaps most important from the mining

[1] F. J. Monkhouse: "The South Limburg Coal Field," *Econ. Geogr.*, Vol. 31, 1955, pp. 126–137.

standpoint are the Tertiary sands and gravels and their more recent cover of sands, gravels, and loess.[2] These are generally water-laden, and in the western Wurm and Inde basins large volumes of water find their way into the Upper Carboniferous strata. Pumping costs are sometimes considerable where this water seeps into mine workings. The water problem had become acute in the Inde basin by 1944, when mining ceased. In some parts of the coal field, however, a thick and impermeable stratum known as "Baggert" lies above the Carboniferous succession, and the influx of water into collieries working these districts is much less than it is where the "Baggert" is thin or absent.[3]

Water seepage is not the only problem arising out of the geological conditions. Seams are not very thick—about 3 feet 10 inches on the average—and are frequently faulted and of variable dip. It is perhaps significant that the output per manshift underground is lower than in the Ruhr or Dutch Limburg.[4]

Throughout the coal field the "horizon" method of mining is used. From the colliery shafts, roadways are driven through stone at different levels to cut the coal seams. The seams are worked on longwall faces between these roadways, and the coal is delivered by chute to the lower roads, where it is discharged into mine cars for transport to the shaft and eventually the surface. The driving of the roadways inevitably involves a considerable capital outlay for the removal of barren stone, but the slight inclination of the "levels" permits the installation of underground railways on which long trains of mine cars can be drawn by diesel locomotives. In this way the manpower employed on haulage duties underground is reduced to a minimum. Horizon mining is widely practiced on the Continent, and the method is used in the neighboring Dutch coal field.[5] As in the Netherlands, most of the coal is won by pneumatic pick, and coal cutters are of small importance.

THE COALS

About 60 per cent of the output consists of coals of an anthracitic, semi-anthracitic, and low-volatile bituminous character which are unsuitable for coking. These are the Esskohlen, Mager-

[2] Thick seams of Tertiary brown coal are worked by open-pit methods near Dürwiss, north of Eschweiler, and at a site east of Herzogenrath. These are mined by a company whose concessions are confined to these coals.

[3] A valuable study of the Aachen coal field is *Die technische und wirtschaftliche Entwicklung des Aachener Steinkohlenbergbaus*, Paul Heinz Oidtmann, 1955 (thesis, two volumes, Technical University, Aachen). This has been drawn upon in the account of the geology above.

[4] *Fifth General Report, European Coal and Steel Community*, 1957, p. 115. Data on costs of production in the coal fields of the Community are not available.

[5] Monkhouse, *op. cit.*, does not make this clear, but the diagram on p. 127 of his article shows conditions of horizon mining.

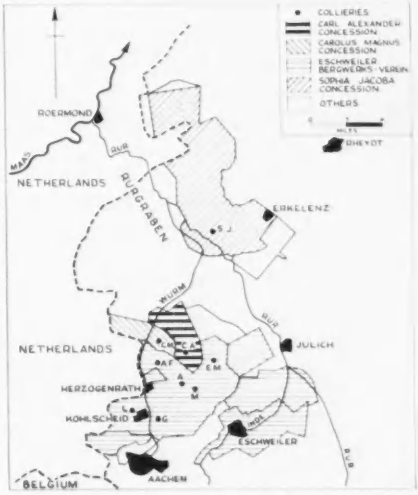

FIG. 1. The major deep-mining concessions of the Aachen area. The collieries indicated by initials are as follows: S. J. Sophia Jacoba; C. M. Carolus Magnus; C. A. Carl Alexander; A. F. Adolf; E. M. Emil Mayrisch; A. Anna; M. Maria; L. Laurweg; G. Gouley. (Base map supplied by Unternehmensverband des Aachener Steinkohlenbergbaus e.V., Aachen.)

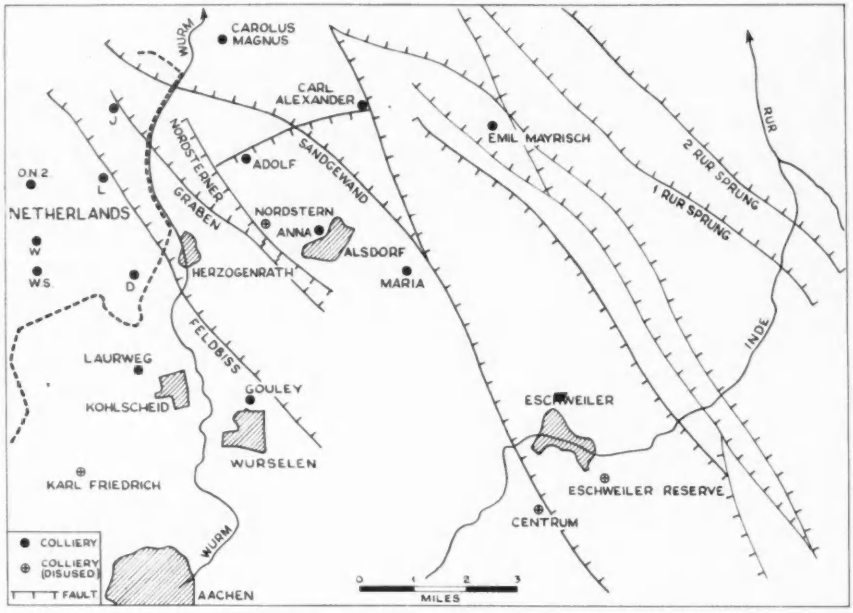

FIG. 2. The fault system of the Wurm and Inde basins (after Oidtmann). The collieries in the Netherlands indicated by initial letters (after Monkhouse) are as follows: D. Domaniale; W. S. Willem-Sophia; W. Wilhelmina; O. N. Oranje-Nassau; L. Laura; J. Julia.

kohlen, and Anthrazitkohlen. The other coals have a somewhat lower carbon content and a higher percentage of volatile matter (Fettkohlen and $^3/_4$ Fettkohlen). It is from these types that coals for coking purposes are selected. Not all collieries produce the whole range of coals. Figure 3 shows that there is a very considerable measure of specialization by type in some collieries.

The reserves of the Aachen coal field are modest. The proved and probable reserves of 10,500 million tons (to a depth of 6500 feet) account for about 5 per cent of the total for the Federal Republic, exclusive of the Saarland.[6]

HISTORICAL DEVELOPMENT

The Aachen coals have been worked for several hundred years. The Wurm seams were worked on the Dutch side of the present frontier in the twelfth century, but extensive workings existed in Germany long before they did in the Netherlands.[7]

The first attempts to win the coal took place in the exposed Coal Measures, and in both the Wurm and Inde basins these were being worked by the fourteenth century. The early mines were shallow bell-pits sunk into the outcrops, and slants driven into the seams where they were exposed in the incised valleys of the Wurm and Inde. Drainage techniques in these mines were of the simplest kind. It was not until early in the nineteenth century that steam engines were used for pumping water from the mines. Old surface workings are numerous near the two rivers and form distinc-

[6] *Jahrbuch des deutschen Bergbaus*, Vol. 50, Essen, 1957, p. 682.

[7] Monkhouse, *op. cit.*, p. 128, cites this date for the working of the Wurm coals.

tive, if minor, land forms. Deeper shaft mining succeeded the shallow workings and seams in the hidden portions of the basins were tapped as mining advanced in depth. Considerable progress was made in opening up the deeper parts of the fields during the latter part of the nineteenth century.

Coal output rose slowly during the first half of the nineteenth century, from 150,000 tons in 1816 to 368,000 tons in 1850. In the 1840's a dozen mines were active in the Wurm basin and six in the Inde basin.[8] Small units were typical. By 1865 output had reached 780,000 tons and ten years later was only a little below the million-ton mark. Thereafter it rose steadily to reach $1\frac{3}{4}$ million tons in 1900.

New and larger collieries, some of which are still in production, were sunk during the latter part of the nineteenth century. Maria, Anna, Gouley, and Laurweg collieries date from the nineteenth-century phase of expansion (Fig. 2). Eschweiler Reserve colliery, the last to work the Inde basin coals, closed only in 1944, after a working life of 90 years.[9]

In spite of the large increase in coal production during the second half of the nineteenth century, the Aachen coal field occupied a less important place in Germany's industrial structure in 1900 than in 1850, for much more massive and

[8] Norman J. G. Pounds and William N. Parker: *Coal and Steel in Western Europe*, London, 1957, pp. 221 and 223. See also p. 98 for notes on earlier developments.

[9] *Cf.*, R. E. Dickinson: *Germany; a General and Regional Geography*, New York, 1953, p. 474.

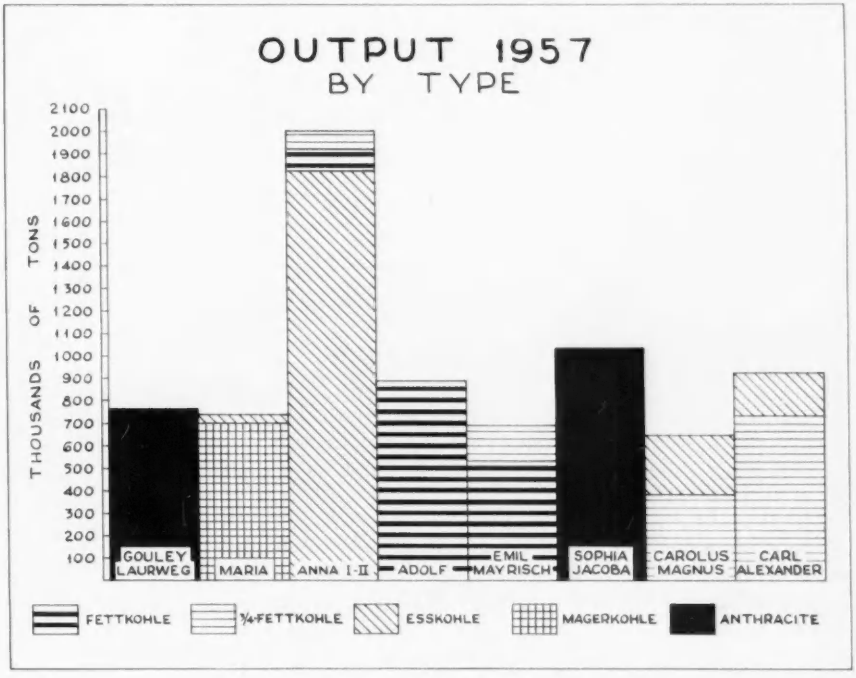

FIG. 3. Coal output of individual collieries by type, 1957.

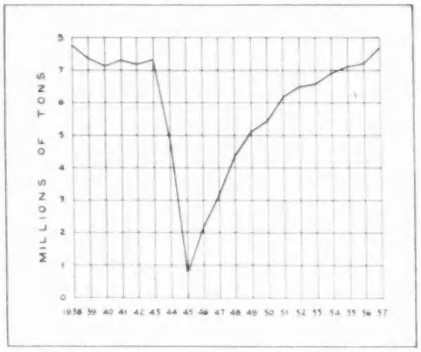

FIG. 4. Coal production of the Aachen district, 1938–1957.

spectacular developments took place in the Ruhr during this half-century. Coal production in the Ruhr rose from about 1,666,000 tons in 1850 to 60,119,000 tons in 1900. Events on the larger coal field during these years were such as to overshadow the more modest progress of the small and rather remote Aachen field.[10]

The iron, and later the steel, industries of the larger coal field also dwarfed similar industries in the Aachen district. Neither supplies of local ore nor the facilities for importing ore and pig iron were comparable in the two coal fields. The blast furnaces have now disappeared from the Aachen district, though their slag heaps remain as evidence of what was once a local industry of some importance.[11]

Since the beginning of the present century there has been a large increase in coal output as more distant parts of the Wurm basin have been developed.

[10] Norman J. G. Pounds: *The Ruhr; a Study in Historical and Economic Geography*, Bloomington, Indiana, 1952, p. 98.

[11] As at Rote Erde, a suburb of Aachen, where furnaces were active until the 1920's. For the metallurgical industries of the area see H. Overbeck, *Das Werden der Aachener Kulturlandschaft*, Aachen, 1928, passim.

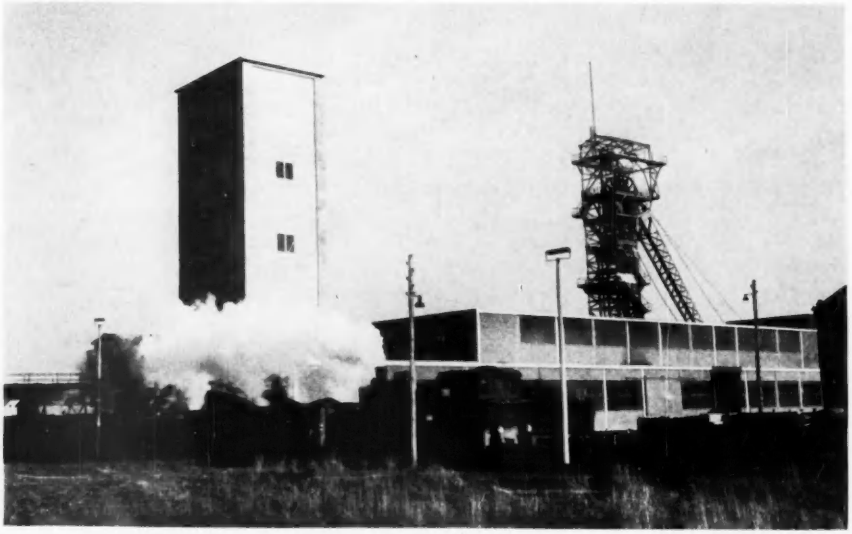

FIG. 5. Emil Mayrisch colliery, Siersdorf, the newest of the Aachen coal mines. Large-scale production began in 1953. In 1957 almost 700,000 tons of coal were raised. The photograph shows the electrically-driven winding gear. (Photograph supplied by Unternehmensverband des Aachener Steinkohlenbergbaus e.V., Aachen.)

Between 1900 and 1925, and again between 1925 and 1935, output doubled, to reach nearly 7½ million tons in the latter year. Subsequent changes are shown in Figure 4.

During the past 45 years new collieries have been sunk north and east of the older mining districts of the Wurm basin.[12] Considerable changes in the landscape have followed these developments. In the 1920's spoil heaps from the new Sophia Jacoba, Carl Alexander, and Carolus Magnus collieries marked the advance of the frontier of mining in the Wurm basin. Waste heaps and pithead-gear intruded far into the highly cultivated Julich Börde. New mining settlements were grafted onto old nucleated villages, which experienced rapid changes in population.[13]

After an interval of 35 years, during which no sinkings were made, a further advance into the concealed coal field has recently taken place. In 1953 the first large quantities of coal left the new Emil Mayrisch colliery, near Siersdorf. This colliery stands in the midst of an agricultural area, though within sight of the older collieries. It is the most easterly of the main group of mines, and one of the deepest in the coal field (Fig. 5).

The new enterprise is owned by the Eschweiler Bergwerks-Verein. This company is the largest of the Aachen colliery companies; it controls almost two-thirds of the total coal output and produces most of the local coke. At one time the company was concerned primarily with the Inde basin coals, but concessions and collieries were secured in the Wurm basin during the nineteenth century. Since the closing of Eschweiler Reserve colliery the company's mining interests have been centered in the Wurm basin. In 1953 more than 90 per cent of the shares of the Eschweiler Bergwerks-Verein were held by the Luxembourg iron and steel firm of ARBED (Aciéries Réunies de Burbach-Esch-Dudelange).[14]

Non-German interests are also predominant in some of the other colliery companies. Sophia Jacoba colliery is owned by Dutch interests; Carolus Magnus by French iron and steel concerns; and Carl Alexander by French and German (Röchling) iron and steel companies. This pattern of ownership is not new. It was established before 1939 and is a good example of the interlocking interests within the western European coal, iron, and steel complex.

LABOR

The labor force engaged in mining and ancillary industries at the collieries (coke ovens, by-product plants, etc.) numbered approximately 31,000 in 1956.[15] This number was about the same as the total number employed in manufacturing in the city of Aachen (population 152,800 in 1956). The city itself has a varied industrial structure, and its fortunes are not so closely bound up with the coal field as the title of this paper might suggest. There is a flourishing School of Mining at the Technical University and the offices of the regional coal sales organization are in the city, but there is no colliery within the city limits. The nearest lie by Würselen and Kohlscheid, some miles to the north.

The numbers employed in mining have been rising steadily since 1945, when fewer than 7000 workers were on the colliery books. There are, however,

[12] Carl Friedrich colliery was sunk northwest of Aachen, close to the frontier, early in the century, but its working life was short.

[13] The population of Baesweiler in 1910 was 1260; and in 1950, 8241. Carl Alexander colliery, on the outskirts, came into production in 1921.

[14] Oidtmann, *op. cit.*

[15] Thirty-three thousand if office staff and non-manual workers are included.

FIG. 6. Anna colliery, Alsdorf. This is the largest colliery on the coal field, and has extensive washeries, coke ovens and by-product plants. Some of these installations appear in the photograph. One of the modern winding towers is shown at the right. (Photograph supplied by Unternehmensverband des Aachener Steinkohlenbergbaus e.V., Aachen.)

still unsolved labor problems, not the least important of which is the large turnover among the underground work force. The largest group of recruits is drawn from within North Rhineland-Westphalia, but all the Länder of the Federal Republic make some contribution, and there is a small non-German element.[16]

[16] *Jahrbuch des deutschen Bergbaus*, 1957, p. 700.

FIG. 7. New miners' houses at Alsdorf-Ofden. (Photograph supplied by Unternehmensverband des Aachener Steinkohlenbergbaus e.V., Aachen.)

DISPOSAL OF THE COAL

More coal, coke, and briquettes were disposed of outside Germany than within the country in 1957. In that year approximately 60 per cent of the disposable output was exported, principally to other member-states of the European Coal and Steel Community. France and Luxembourg were the best customers, but every member-state except Italy took more than 100,000 tons (Table I).

TABLE I

EXPORTS OF COAL, COKE AND BRIQUETTES TO DESTINATIONS OUTSIDE WESTERN GERMANY, 1957*

	Tons
France	1,330,000
Luxembourg	897,000
Saar	564,000
Belgium	495,000
Netherlands	406,000
Italy	68,000
Others	136,000
Total	3,896,000

*The Saar was united politically with the Federal Republic in January, 1957, but is listed with the foreign states in the statistics for 1957 used here. It has been retained for comparative purposes.

TABLE II

SALES OF COAL, COKE AND BRIQUETTES TO CONSUMERS WITHIN WESTERN GERMANY, 1957*

	Tons
Industries other than iron	1,260,000
Iron industries	21,000
Domestic consumers	874,000
Railways	274,000
Electricity plants	221,000
Others	16,000
Total	2,666,000

*Figures of total coal output and disposal do not coincide because of losses in coking and briquetting, and because of coal consumption at collieries.

There have been increases in the volume of trade with all these countries (except the non-Community countries) during the past five years. The most striking increase has been in trade with Belgium, which has risen from 15,000 tons in 1952.

The Aachen coal field lies in a peripheral situation with respect to the major German markets, and it is of interest that the home market has been declining in relative importance since the formation of the European Coal and Steel Community (1952). It would appear that the freeing of intra-Community trade in coal has allowed Aachen producers to take advantage of their position on the western frontier and to expand their trade with areas in which the competitive position of Aachen coal vis à vis Ruhr coal is more favorable than it is within Germany.

The figures given in the table include coke and briquettes as well as coal. Only a small proportion of the total coal output is coked and briquetted locally, however. In 1957 approximately $1^{3}/_{4}$ million tons of coal went to coke ovens on the coal field, and from this 1,375,000 tons of coke were produced. Coke ovens at Anna colliery produce all the coke, with the exception of a very small output of special quality coke made at Carl Alexander colliery. The extensive coal preparation and by-product plants of Anna colliery are shown in Figure 6. Maria, Laurweg and Sophia Jacoba collieries have briquetting plants.

Table II shows the most important users of coal within the Federal Republic. There are no navigable waterways in the area, and rail transport is used to convey most of the coal to its destination. Some goes by water in the later stages of its journey, but the proportion is less than one-third of the total.

SUMMARY

The small Aachen coal field is dwarfed by its greater and better-known neighbor to the northeast, but it affords examples of a number of features of geographical interest. In the older mining districts spoil heaps, derelict headgear, and colliers' rows recall areas with a similar history elsewhere. In the newer mining areas the collieries stand in an agricultural countryside in which they and their associated settlements form distinctive and expanding units (Fig. 7). The Aachen coal field produces only a very small part of Western Germany's coal output (of over 133 million tons in 1957), but the deep-mined coal is all of high rank, and some is suitable for making metallurgical coke. The foreign ownership of the concessions and the importance of non-German markets are notable features of the area.

ACKNOWLEDGMENTS

The authors would like to thank Dr. Philipp, of the Unternehmensverband des Aachener Steinkohlenbergbaus e.V., who kindly supplied all statistical information other than that for which credit is given in footnotes; Professor Fritzsche, of the Technical University of Aachen, who made arrangements for a visit to a colliery; and Mr. Lange, Technical Director, Carl Alexander colliery, Baesweiler, who acted as host and guide on that occasion.

DRAINAGE AND ECONOMIC DEVELOPMENT OF POLES'YE, U.S.S.R.

R. A. French

Mr. French is Lecturer in the Geography of Eastern Europe at University College, London. He has specialized in the historical geography of the U.S.S.R., particularly on questions of swamp drainage, forest clearance, and settlement.

POLES'YE is the wide tract of swamp and forest, often known as the Pripet Marshes, lying in the west of the European U.S.S.R. It occupies the basin of the River Pripyat', right bank tributary of the Dnepr, and the watersheds with neighboring river basins. To the south the area is bounded by the northern fault edge of the Volyno-Podol'sk Upland. Northwards the forest and swamp give way to open, drier lands on the rolling, morainic country of the White Russian Ridge. On the west Poles'ye extends to the political frontier on the Bug; to the east it merges with the Middle Dnepr Lowlands. Since 1939, when the western, Polish part was acquired, the whole area has been included in the White Russian and Ukrainian Republics (Fig. 1).

The Physical Setting[1]

Over 300 miles from west to east and 150 miles from north to south, the Polessian basin is shallow with ill-defined watersheds and indeterminate drainage. The fall of the Pripyat' in its 370-mile course is only some 230 feet. The area is almost entirely covered by fluvio-glacial sands and clays from the final, "Valday," glaciation and by lacustrine-riverine alluvium (Fig. 2). These deposits have greatly complicated the drainage pattern and caused waterlogging and swamp formation. There are over a thousand perennial lakes and many others are formed in the spring floods. These floods extend up to six miles on either side of the Pripyat' and up to a mile on either side of its tributaries. "Islands" of dry land are scattered throughout the swamps and floodplains, on the remnants of the third Dnepr loessial terrace, which was largely eroded from Poles'ye in glacial times; on the chains of fluvio-glacial sand dunes which flank the rivers; and on the rare, small outcrops of the underlying Cretaceous and Tertiary rocks.

Reed and grass marshes and peat bog cover about a quarter of the surface area (Fig. 3). Peat bogs are less extensive than the marshes and are to be found mostly in south central Poles'ye. The largest area of reed marsh is that lying south of Pinsk, with reeds and rushes dominant in the vegetation and with innumerable tiny channels choked by lilies and other water plants. Most widespread of all are the grass marshes of carex, molinia, and nardus, particularly on watershed areas. Most of the lakes are in various stages of invasion by marsh or bog, while these in their turn often suffer encroachment by forest.

[1] Based on L. S. Berg, *Geograficheskiye Zony Sovetskogo Soyuza*, Moscow, 1947; B. F. Dobrynin, *Fizicheskaya Geografiya S.S.S.R.*, Moscow, 1948; and I. P. Gerasimov i K. K. Markov, *Lednikovyy Period na Teritorii S.S.S.R.*, Moscow-Leningrad, 1939.

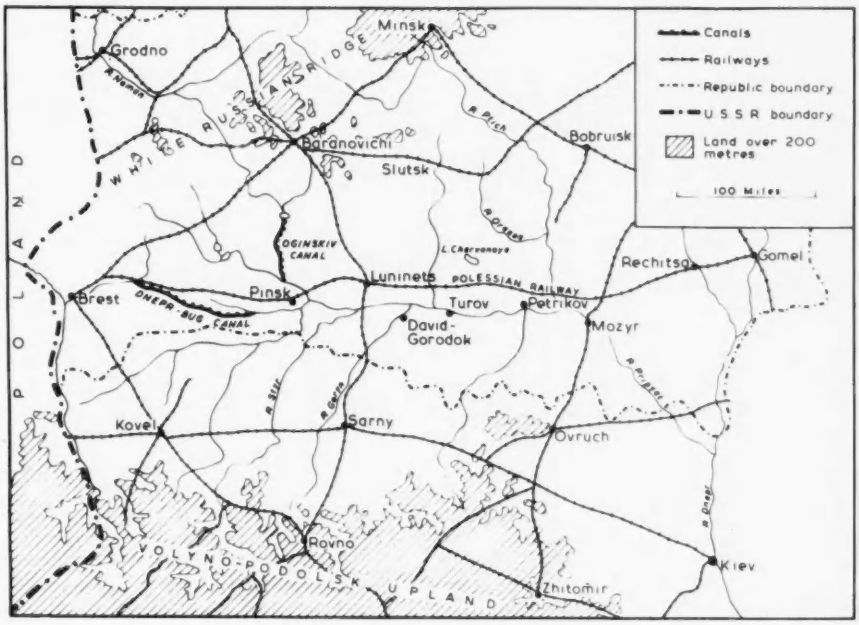

FIG. 1. The location of Poles'ye.

Birch-sedge swamp complexes are common. Later, alder, aspen, and willow become dominant in wet areas, often standing on hummocks of marsh plants. The sands are almost wholly occupied by pine, the most common species of tree in Poles'ye. Drier, terrace areas of clay loams and loess are covered by forests of oak, hornbeam, and birch. In many parts, 30 to 60 per cent of the surface is forest covered.

POLES'YE IN THE 1860'S[2]

In 1868, a Russian topographer, Ivan Eremich, wrote, "For many of us, the lands of the African wilds, explored by the missionary Livingstone, are better known than the White Russian Poles'ye of western Russia. It is practically an America in Europe, awaiting its Columbus." His description shows Poles'ye not only to have been extremely backward in its economic development, but indeed to have changed little since medieval times. Its inhabitants made a scanty living from the primitive cultivation of rye, oats, millet, and potatoes. Plowing was by oxen or even, for the poorest peasants, by ox and cow in harness together. Table I indicates the low proportion of arable and the high proportion of forest and swamp in the "uyezdy," or districts, of the Minsk Government in which nearly all Poles'ye then lay. This is particularly noticeable in the uyezdy of Pinsk and Mozyr which were wholly within the confines of Poles'ye.

Cattle and pig rearing were more important in the economy than cultivation, being favored by the rich natural meadows of the floodplains but hindered by the depredations of the bear and wolf. Nevertheless, despite the sig-

[2] Based on I. Eremich, *Ocherki Belorusskago Poles'ya*, Vilna, 1868; and N. Stolpyanskiy, *Devyat' Gubernii Zapadno-Russkago Kraya*, 1866.

TABLE I

LAND USE 1860

Percentage of total area

Uyezdy	*Slutsk*	*Pinsk*	*Mozyr*	*Rechitsa*
Kitchen gardens, etc...	1.3	0.7	0.3	.7
Arable	34.9	15.1	9.9	20.3
Meadows	15.8	16.5	7.4	9.8
Forests	40.7	43.1	58.1	53.6
Swamp	7.0	23.3	23.0	14.3
Sands, water, etc.....	0.3	1.3	1.3	1.3

After N. Stolpyanskiy.

TABLE II

LIVESTOCK 1860

In thousands of head

Uyezdy and area in square miles	*Slutsk 2490*	*Pinsk 4509*	*Mozyr 6194*	*Rechitsa 4720*
Horses	98	7	5	4
Cattle	154	39	27	36
Sheep	31	41	15	24
Pigs	34	12	19	19
Goats	18	18	3	4

After N. Stolpyanskiy.

nificance of livestock to the Polessian peasant, Table II shows that total head was very low in the central uyezdy in comparison with those bordering the swamp area. Mozyr Uyezd, for example, had 27,000 head of cattle as against 154,000 in Slutsk Uyezd, which was only half as large but which included land north of the Polessian swamps.

In many villages, fishing rather than agriculture was the main form of livelihood, especially in the neighborhood of Lake Chervonoye. Bee keeping was widely practiced as a supplementary

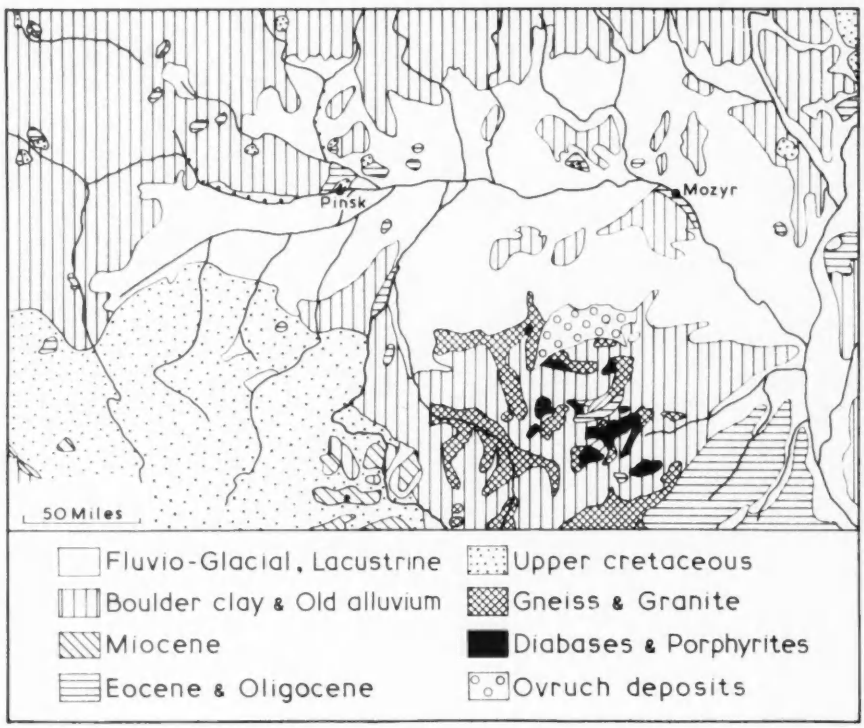

FIG. 2. The geology of Poles'ye.

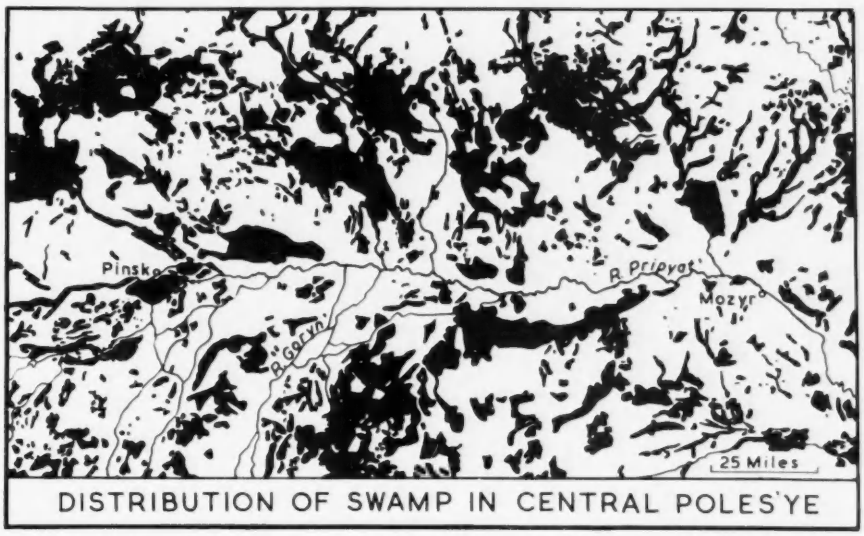

FIG. 3. Swamp distribution in central Poles'ye. (Source: 1:300,000 map of Poles'ye, prepared by German General Staff, 1941.)

source of income. Here and there in remote huts in the swamps, lived prospectors—the "rudnik" who dug for bog iron ore and the "budnik" who dug for potash.

Only along the Pripyat' itself was there any economic link with the rest of Russia. The river had been linked with the Neman by the Oginskiy Canal built between 1797 and 1804 and with the Bug by the Dnepr-Bug Canal, built 1839 to 1843. Timber was cut and rafted by these canals to Poland and the Baltic and also downstream to the Dnepr towns of Kiev and Kremenchug. Both waterways were small, however, and subject to silting, and in the latter part of the nineteenth century navigation on the Oginskiy Canal was possible only in spring, and the Dnepr-Bug Canal necessitated transhipment at Pinsk to smaller barges.

In the 1860's, settlement in Poles'ye was confined to the dry "islands," particularly where such sites occurred near the rivers. Many villages were accessible only by water and throughout the region the canoe was the usual form of transport.

THE FIRST DRAINAGE, 1872–1897[3]

Poles'ye, backward and poverty stricken as it emerges in Eremich's description, was on the eve of considerable developments. In 1872 work was put in hand for the drainage of Poles'ye by the Ministry of State Domains, under the direction of General Zhilinskiy and the "Western Expedition for the Draining of Swamps." By 1897 over 3000 miles of canals had been constructed, 1540 square miles of former swamp had been converted to water meadow and 485 square miles to arable, 2700 square miles of forest had been drained and made accessible, and 5216 square miles of land where drainage was not essential

[3] Based on V. P. Semenov Tian Shanskiy (edit.), *Rossiya*, Vol. IX, Verkhneye Podneprov'ye i Belorussiya, St. Petersburg, 1905; and A. Voeikov, "Pinskoye Poles'ye i Rezul'taty yego Osusheniya," *Izvestiya I. R. G. O.*, Vol. 29, 1893.

had been improved. Most of the drainage initially was in the areas of State forest. One-third of the reclaimed land was government owned and the rest was in private hands. Private landowners had to bear a proportion of the cost but in some places peasants were allowed to pay for drainage with labor.

The results of this work were far-reaching. The value of improved land rose on average by 600 per cent from four rubles per "des'yatin" (2.7 acres) to 28 rubles. Speedier disposal of flood water was possible; sluices on the canals controlled the water table and gave rise to vastly improved meadow. The area of hay crop on State property rose from 27,000 acres in 1878–1879 to over 160,000 acres in 1896–1897. The number of cattle in Poles'ye increased from 460,000 to one million. Most important of all was the increase in timber production, the canals permitting rafting from formerly inaccessible forests. An agricultural experimental station was established at Babichi near Vasilevichi to demonstrate the best methods of using reclaimed land. The mixture of the drained peat and underlying sand by deep plowing gave an excellent soil.

The operations were not carried out without opposition. At the instance of engineers who claimed that the Dnepr-Bug Canal would be deprived of its water supply and that the level of navigation on the Pripyat' would be lowered, wide swamp areas near Pinsk were left unreclaimed. Lake Chervonoye was left untouched on account of its value to the fishermen of near-by villages.

During this period, another development played a most significant role in the economic geography of Poles'ye—the construction in 1882 of the Polessian Railway from Brest to Pinsk. The next year it was extended eastward across the whole of Poles'ye to Gomel'. Built by the State as a strategic railway, the line assumed great commercial importance and during the 1890's carried 1,600,000 tons annually, mostly timber and grain. Luninets, the junction with the north-south line from Baranovichi to Rovno, handled 86,000 tons of these goods each year. In contrast: the wharf at Pinsk handled only 4300 tons of cargo and its grain elevators became disused and fell into ruins.

POLES'YE FROM 1897 TO THE REVOLUTION[4]

Despite the improvements and economic advance which resulted from the drainage operations and the advent of the railway, Poles'ye at the end of the nineteenth century and down to the Revolution was a poor and backward area. Rye, oats, buckwheat, and potatoes remained the staple crops. The area under potatoes increased considerably, above all in the last two decades of the nineteenth century. Market gardening was of some importance around Turov, Davidgorodok, Petrikov, and Pinsk, mostly for local consumption. Some fruit was sent to the Dnepr towns and to Poland. Honey and wax were still valuable items in the economy, and the annual honey production of the Pinsk and Mozyr Uyezdy was almost 100,000 kilograms.

The figures for 1905 show that the greatest increase in the arable area since 1860 was in the east (Table III). In Pinsk Uyezd there had been little change. (The increase in the last category may be attributed to the reclassification of scrub or swamp forest as waste.)

On the newly reclaimed land flax and hemp were introduced and the importance of these crops gradually increased during this period.

[4] Based on G. T. Kovalevskiy i F. S. Martinkevich (edits.), *Belorusskaya S.S.R.*, Moscow, 1957; and V. P. Semenov Tian Shanskiy, *op. cit.*

TABLE III

LAND USE IN PINSK AND MOZYR UYEZDY

In percentages of district totals

	Pinsk Uyezd		*Mozyr Uyezd*	
	1860	*1905*	*1860*	*1905*
Forest	43.1	38.5	58.1	41.0
Arable	15.8	16.5	10.2	17.0
Meadow and pasture	16.5	18.5	7.4	8.0
Swamps and waste	24.6	26.5	24.3	34.0

In general, implements and technique alike were primitive. Over nearly all the Minsk Government the three-field system was still practiced, while some villages had only a two-field system. In the Government, the annual per capita deficiency of bread was 67 kilograms. Very few peasants owned land. The village communities, in 1887, owned 29 per cent of the land of the Government, the State 12 per cent and private landowners 59 per cent. Of that 59 per cent, peasants owned 1.4 per cent and the nobility 93.4 per cent, the rest belonging to merchants and townsfolk. In Poles'ye itself, the proportion in the hands of the State and landed gentry was higher still. These figures remained substantially the same to the Revolution, apart from the parcelling out of community lands in the agricultural reforms of 1906. Not surprisingly, the rate of emigration was high and in 1905, from Mozyr Uyezd alone, 13,000 people moved away to Siberia or other parts of Russia or abroad.

The breakup of the village community in 1906 led to a marked change in the pattern of settlement. Many "colonies" of dispersed small farmsteads or "khutora" were established away from the large, nucleated villages which had characterized the area. This centrifugal movement, which was common over much of Russia, was here facilitated by the existence of the recently reclaimed land.

Since the Emancipation of Serfs in 1861, a number of small-scale industrial enterprises had been set up. These rarely employed more than ten workers and were mostly concerned with processing natural and agricultural products for local consumption, such as distilling, brick making, saw milling, and flour milling. Shipbuilding was carried on at Pinsk and boat building at Davidgorodok, Mozyr, and Balazhevichi. Here and there on the sands were small glass works. The 1897 census figures reveal how very small a part such activities played in local life (Table IV).

Even in Pinsk, the chief town of the swamps, these works accounted for less than 6 per cent of the total population of 28,000. The 22 concerns included a shipyard, a match factory, three sawmills, a candle factory, four distilleries, and five honey processing works.

Early in the twentieth century, larger industrial undertakings developed in Poles'ye, for the most part engaged in timber processing. At Pinsk, a veneer works in 1910 employed some 500 workers, and the match factory was of similar size. Sawmilling and veneer making were established at Mikashchevichi. At Telekhany, on the Oginskiy Canal, there was a large glassworks.

Much more important than industry

TABLE IV

MANUFACTURING IN 1897*

		Number of concerns	*Number of workers*
Pinsk	Town	22	1588
	Uyezd	36	645
Mozyr	Town	3	564
	Uyezd	28	363
Rechitsa	Town	2	53
	Uyezd	41	367

*Tsentral'nyy Statisticheskiy Komitet Ministerstva Vnutrennykh Del, *Pervaya Vseobshchaya Perepis Naseleniya Rossiiskoy Imperii 1897g.*, St. Petersburg, 1898.

was the exploitation of the forests. In autumn and winter, the timber was cut and drawn to the landings or rail loading points and in summer it was rafted down to the Dnepr. In 1897, there were 1221 rafts sent downstream from the Pripyat' and its tributaries. In Pinsk Uyezd 2000 persons were so employed—in Mozyr Uyezd 3200 and in Rechitsa Uyezd 3500.

POLES'YE FROM 1917 TO 1941[5]

The outbreak of the First World War brought devastation to the area, devastation increased by the subsequent Russo-Polish campaigns and the Civil War with its concomitant famines and epidemics, until the 1921 Treaty of Riga divided Poles'ye between Poland and the U.S.S.R. The population was seriously depleted and most of the drainage works were destroyed or allowed to fall into disuse and to silt up. The sown area in 1920 was only 70 per cent of that in pre-war years, and the grain harvest was only 47 per cent. The head of cattle had decreased by 34 per cent and of pigs by 56 per cent. In the newly formed White Russian Republic, 480 out of 750 industrial enterprises had been destroyed or removed.

Gradually recovery was made. On

[5] Based on G. Kazakov, *The 1952 Plan for the Draining of the Pripet Marshes*, Research Program on the U.S.S.R., Mimeographed Series No. 43, New York, 1953; and G. T. Kovalevskiy i F. S. Martinkevich, *op. cit.*

FIG. 4 (left). Settlement distribution in the Turov Area in the 1860's. (Source: 1:126,000 map of Russia, published by the Military Topographical Depot in St. Petersburg, 1866–1869.)

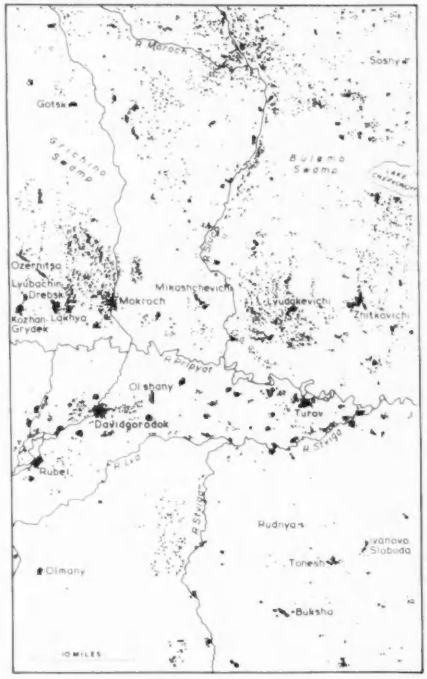

FIG. 5 (right). Settlement distribution in the Turov Area in the 1930's. (Source: 1:100,000 map of the U.S.S.R., published by the Chief Geodetic Administration and Directorate of Military Topographers of the Red Army, 1933–1936.)

both sides of the frontier the trend towards dispersed settlement continued, with the establishment of "khutora." In Poland this dispersion was reinforced by the settlement of thousands of "osadniki," ex-soldiers and their families, on plots of 10 to 24 hectares. How great a change was wrought by this movement is indicated by Figures 4 and 5 which show settlement in the Turov area of central Poles'ye in the 1860's and 1930's respectively. Later the trend to dispersal was reversed in the U.S.S.R. and between 1939 and 1941 over 180,000 "khutora" in the White Russian S.S.R. were reorganized into villages. By then there were 150,000 such farmsteads in the western, Polish areas.

Drainage occupied the attention of both governments, but on the Polish side little was done beyond the setting up of a Bureau for the Improvement of Poles'ye and the carrying out of surveys. In the Soviet Union the peasants were organized into "Reclamation Co-operatives" and some 24,000 acres were drained by individual state farms and collectives, mostly in the Oressa valley. With the reuniting of both parts of Poles'ye in 1940, the tempo of reclamation was quickened. The Dnepr-Bug Canal was reconstructed and nearly 20,000 miles of ditches and drains were dug. In all the White Russian Republic some 700 square miles were drained in 1940, and by the outbreak of war the total area of reclaimed land had risen to over 1000 square miles. On the eve of war in 1941, an ambitious 15-year plan was drawn up to drain nearly 16,000 square miles (four million hectares) in White Russia, the greater part of which was to be in Poles'ye. Of the land so recovered, 60 per cent was to be water meadow and pasture and 40 per cent arable.

Poles'ye Since the Second World War[6]

For the second time in less than 40 years Poles'ye suffered most grievous damage, and when the Second World War ended in 1945, the area was once more in chaos. Recovery was considerably faster, however. Even before the war had ended, the Dnepr-Bug Canal had been rebuilt yet again by Soviet Army engineers. Since then it has played a not insignificant part in trade with Poland, with iron ore and manganese moving westwards and coal moving eastwards. Nevertheless, it is still navigable by small craft only, and it is proposed to widen the canal. The Oginskiy Canal has now fallen into complete disuse.

Drainage has continued, and since the war about 400 square miles have been reclaimed in Poles'ye, 150 in Brest Oblast, and 250 in Gomel' Oblast. The River Ipa has been regulated and over 50 square miles of its valley drained. The Nineteenth Party Congress in 1952 called for an increase of 40 to 45 per cent in the area of drained lands in the Soviet Union and named Poles'ye as one of the major areas involved. The President of the White Russian S.S.R., Patolichev, stated that three and a half million hectares (about 14,000 square miles) stood in need of reclamation, to which may be added another million hectares, or 4000 square miles, in the Ukraine. To assist the work, Machine Reclamation Stations have been established, with over 200 Reclamation Units attached to Machine Tractor Stations to provide machinery for excavating ditches, putting in mole drains, and

[6] Based on G. T. Kovalevskiy i F. S. Martinkevich, *op. cit.*; G. T. Kovalevskiy i Ya. G. Rakov (edits.), *Belorusskaya S.S.R. Ocherki Ekonomicheskoy Geografii*, Minsk, 1953; and I. S. Lupinovich, S. G. Skoropanov i Z. N. Denisov, *Preobrazovaniye Prirody Polesskoy Nizmennosti*, Moscow, 1953.

deep plowing. Despite these efforts, I. I. Trukhan in "Belorusskaya S.S.R.," published in 1957, comments that "the development as a whole of drained lands is still going slowly."

Industry in the area is still largely concerned, as formerly, with timber and food processing although glass making has disappeared. Timber working represents 24 per cent of the industrial output of Brest Oblast and food processing 46.5 per cent. The size and number of enterprises has increased markedly. Veneer and match manufacture at Pinsk has been joined by furniture making. Furniture is also made at Mozyr and Luninets. Another match factory is in operation at Petrikov. Wooden barges are constructed at Petrikov and Narovlya, and shipbuilding continues at Pinsk. Food processing is important at Pinsk, Davidgorodok, Kalinkovichi, and Khoiniki. A new source of power is the peat-burning power station now under construction at Vasilevichi, near Mozyr; and a second, larger station, also using peat, is planned at Bereza northwest of Pinsk.

There have also been advances in agriculture and many collectives and state farms are obtaining high yields from drained lands. Flax and hemp are still the leading industrial crops, occupying up to 9 per cent of the sown area. Rye, oats, buckwheat, and potatoes retain their dominance. Potatoes take up to a quarter of the sown area and are used for human and animal consumption as well as for starch and alcohol production. The greatly increased acreage of controlled meadow and pasture has led to increased numbers of livestock, averaging 34–35 head of cattle per 100 hectares of agricultural land and 58–70 pigs per 100 hectares of arable land.

Nevertheless, even with all these advances, Poles'ye today remains a poorly developed area. The proportion of arable, under 20 per cent, is lower by far than in any neighboring region. In some rayony, or districts, such as those of Turov and Davidgorodok, it is under 7 per cent. The area as a whole is still over 50 per cent forested. Some rayony have up to 60 per cent of their surface in swamp or waterlogged ground. Much has been done over the years to drain and develop what John Murray in his 1893 *Handbook for Travellers* called "this dismal swamp," but the major task of reclamation lies ahead.

BOOK REVIEWS

The Geography of Air Transport, by KENNETH R. SEALY. 207 pp.; maps, diagrs., tables, bibliogr., index. Rinehart & Company, Inc., New York, 1958. (Hutchinson University Library, London, 1957.) $1.50. $7\frac{1}{2} \times 4\frac{3}{4}$ inches.

In *The Geography of Air Transport*, Kenneth R. Sealy, Lecturer in Geography at the London School of Economics, has attempted to spin the relatively few geographic studies of air transportation into a world coverage of the subject. The results although weakly unified are of interest as an initial assemblage of scattered material in a new field of geographic concern.

The book is organized into three parts of unequal length. The introductory section covers physical and technical background material; the section on patterns covers world, European, United States, and Canadian air transportation; and a short final section deals with airports. In the section on air transportation patterns which constitutes the core of his work, Sealy presents a number of interesting generalizations about world and continental air routes. For instance, he points out how the development of the Karachi-Calcutta-Bangkok axis has meant the decline in the strategic situation of Colombo, and how Gander and the Azores function as air-age equivalents of the coaling stations. Great circle routes also come in for considerable attention in the air route section. Although their importance as distance-minimizing paths has, by this time, become something of a straw man, Sealy does a workmanlike job of pointing out the greater importance of such other route pattern determinants as national control of airspace and the need for supporting traffic. He makes effective use of great circle routes in his pattern description by comparing the actual connections of an area such as the United States with a hypothetical great circle pattern. It should be noted, however, that Sealy occasionally shows a tendency to accept uncritically sweeping situational generalizations which are both pretentious and difficult to support, as in his description of the disadvantageous peripheral position of North America.

Sealy's discussion of European air transportation is perhaps his best. He notes the high density, short-haul nature of the route structure, the striking contrast between over-land and over-water routes, and the potentially strategic situation of Berlin and Warsaw with respect to East-West traffic. Most of these generalizations as well as the route density maps were drawn from *The Economics of European Air Transportation*, by Stephen S. Wheatcroft (Harvard University Press, 1956), an excellent analysis of some of the problems occasioned by the complex European route structure. Sealy goes on, however, to apply to European air transportation some of the ideas of traffic shadow and city function as they have been developed in geographic studies. A particularly striking finding here is the extreme development of traffic shadow in the Paris-Groningen zone where only four of the 20 cities with populations in excess of 100,000 have scheduled air services.

Sealy's awareness of the need for generalization is one of the book's strong points. His pattern descriptions are unusually clear and he persistently attempts to extract broad generalizations from the available case studies. Thus, although *The Geography of Air Transport* is eclectic to the point of verging on a scrapbook, it is by no means an interpretation-free, factual compendium of air transportation minutiae. It should be noted, however, that the forced nature of these generalizations is in itself something of a weakness since such speculations upon meager evidence are seldom consistent with one another.

Selection of material probably constitutes the chief ground for criticism of this work. Space is such a scarce resource in a 196-page treatment of world and continental air transportation that selection criteria must be particularly rigorous. However, some of Sealy's criteria for inclusion of material in the chapter on physical geography and in the physical and regional introductions to Europe and the United States seem to have been dictated more by geographic custom than by relevance to existing air transport patterns. Although such patterns as upper winds and airfield visibility are certainly linked to air routes, they are of secondary importance at best as pattern determinants. Further, it hardly seems useful to devote space to establishing a rationale for a settlement pattern in the physical geography of an area when the emphasis should be on exploring the ramifications of relations between a given settlement pattern and air routes. The pedagogic momentum associated with this type of exposition frequently carries Sealy a bit beyond his goal, as when he finds himself involved in brief explanations of meteorological processes or of how to define Western Europe. The cumulative effect is to overemphasize phenomena which are reflected only incidentally and often indirectly in the pattern of air transport. The reader is left with a severely limited view of the immediate and operational environment in

which air transportation has developed. Instead of receiving a glimpse of spatially complex economic forces at work in a setting of even stronger legal-political forces, he is presented with a set of passive, introductory-course cliches.

In part, this may be associated with Sealy's apparently weak substantive knowledge of air transportation, particularly United States air transport. He notes that United States airlines have been subsidized without pointing out that they are now virtually all off subsidy; he discusses the importance of the Trans-Pacific great circle route without mentioning the colorful struggle still going on between Pan American World Airways and Northwest Airlines for control of this route. His selection of tabular data for inclusion in the technical and economic section seems haphazard. Operating characteristics of many currently significant aircraft are omitted and there is little comparability in the scattered economic data utilized. Here it might be noted that the device of evaluating sample air cargoes did seem to be effective, although it is questionable as to whether he had to reach as far as iron ore and potatoes to find unprofitable bulky cargoes.

Other important by-products of Sealy's overemphasis of material of secondary relevance are the limitations which it imposed upon his treatment of underdeveloped areas and on his space available for maps. Since his "underdeveloped" example is Canada, the book contains no discussion of the underdeveloped areas of high population density and low per capita income. The absence of maps in general is a serious weakness. Clarity of expression alone proves unequal to the task of map-less pattern description in many instances such as the detailed discussion of British European Airways' route network, and the ill-fated attempt briefly to characterize route networks of individual United States airlines. He also was unable to use some of the excellent route and flow capacity maps prepared by the International Civil Aeronautics Organization. Some of these are used in *Geographie de la Circulation Aerienne* by Eugene Pepin (Paris: Gallimard, 1956), a book which is similar to Sealy's in some respects but places greater stress on legal and technical aspects of air transportation. Of the maps used, it is unfortunate that the frequently-cited world route map is not only small-scale but is needlessly complicated by inadequate distinction between flow lines and lines of latitude and longitude.

In some respects, a book dealing with the geography of air transportation is premature. No reasonably cohesive body of generalizations exists, and there have been few substantive geographic studies of the subject. Nonetheless, Sealy has performed a distinctly useful service in collecting existing geographic studies, and his persistent attempts to generalize should provide both stimulation and orientation to geographers initiating future research on air transportation.

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Conservation in the Production of Petroleum: A Study in Industrial Control, by ERICH W. ZIMMERMANN. xxii and 417 pp.; tables, charts, index, bibliogr. Petroleum Monograph Series, Vol. 2, Yale University Press, New Haven, 1957. $6.00. 9½ x 6 inches.

The Future Supply of Oil and Gas, A Study of the Availability of Crude Oil, Natural Gas, and Natural Gas Liquids in the United States in the Period through 1975, by BRUCE C. NETSCHERT. xiv and 134 pp.; tables, index. Published for Resources for the Future, Inc., by The Johns Hopkins Press, Baltimore, 1958. $3.00. 8½ x 5½ inches.

Recent successes with new and unconventional sources of energy cannot hide the fact that it is fossil fuels that still make the wheels of the world go around. Both of these studies of the oil and gas economy of the United States emphasize that the future availability of these two premium fuels will depend as much on how wisely we develop and manage these resources as on the total quantities of them that may exist. Their authors conclude that, despite the continuing growth in demand, the time of shortages and substantially higher prices may yet be many years ahead.

Zimmermann's monograph, sponsored by the American Petroleum Institute but prepared and published under the direction of an independent board of editors, is an exhaustive analysis, rich in technological and historical detail, of the controversial role of state regulation in the production of oil and gas. The stated purpose of such regulation is the prevention of waste and the protection of correlative property rights. The adjustment of crude oil supply to "reasonable market demand" through state allowables, and its proration among the fields, pools, and individual properties in the states, has come to be one of the principal bulwarks of this program. Such limitation of production has been claimed by some critics to be nothing more than a monopolistic price-fixing device for the enrichment of private interests under the thinly veiled guise of "conservation."

Zimmermann gives an unequivocal endorsement to the industry-supported and state-administered proration programs. He sees them to be socially desirable activities made necessary by the singular character of petroleum's occurrence and production which makes it impossible to rely exclusively on the free play of the market for the maximization of economic values. Pro-

rated production, like well-spacing, unitization, and restrictions on gas-oil ratios, is shown to be clearly basic to the prevention of physical waste and its corollaries, the reduction of unit costs and the increase in the ultimately available supply of crude oil. Conservation is defined not as "sparing use to delay inevitable exhaustion" of a fixed quantity of oil and gas, but rather as the creation of a favorable economic and institutional climate for the "unfolding" or development of these resources. The price stabilization that has resulted from prorationing has encouraged investment, exploration, and technological advance within the industry and so has contributed significantly to the achievement of this goal.

Natural gas conservation problems, including the effect of the artificial underpricing of gas relative to competing fuels, constitute a special section in Zimmermann's study. Another is concerned with the question of imports. The extent to which the high profits from foreign oil have depended on the maintenance at a high level of posted Gulf Coast crude oil prices, which have set the world price and for which the Texas Railroad Commission is largely responsible, will seem to some readers insufficiently emphasized. It is clear that the increasing pressure of low-cost foreign oil on United States markets derives from the attractiveness of the cost-price spread.

The opening chapters, in which the static inventory concept of resources is rejected and the semantic problems posed by the terms "resources" and "conservation" are reviewed, are by all odds the best in the book. Their tight organization and lucid exposition are Zimmermann at his best and contrast markedly with the rambling and sometimes repititious style of the later sections. But, whatever its weaknesses, this impressively documented, fact-filled book, written by an eminent resource economist who has become steeped in the lore and technology of petroleum through long residence in the state of Texas, will stand as a towering milestone in the literature of conservation.

Netschert's study for Resources for the Future, Inc., is something quite different. It is an ambitious attempt to review the total potentially available oil and gas reserves that may exist within the limits of the United States and the probable availability of these fuels in the year 1975. It is aimed less at establishing a new estimate of oil and gas reserves and availability than at building on old estimates in the light of considerations that the author believes have not received sufficient acknowledgment or emphasis. Like the first, this is an economic study, based on the analysis and interpretation of technical opinion and the facts from which that opinion is derived.

The author aligns himself uncompromisingly with the optimists. His survey of the massive body of technical literature on future reserves and productive capacity is impressively detailed and, apparently, exhaustive. He believes that improved technology applied to the business of oil and gas exploration and development in this country should be able to keep pace with an expanding market demand for at least two decades without significant increase in constant dollar costs. The freshness of the author's approach stems in part from his careful avoidance of mechanical extrapolations of statistical trends and his attention to the variables that seem to determine the trends. Among these variables the promise of technology stands pre-eminent. The dramatic potentialities of deep-well and offshore drilling, and of the numerous new techniques employed in secondary recovery operations are described. The last, especially, is believed capable of providing an explosive boost to total yearly crude oil production in the years immediately ahead.

Like Zimmermann, Netschert stresses the basic distinction between "reserves" and "resources." To this end he develops estimates of a "resource base," defined as the sum total of crude oil, natural gas, and natural gas liquids present in the earth's crust within the United States, whether known or unknown and regardless of present technologic or economic feasibility of extraction. With such figures at hand (500 billion barrels of crude oil, 1200 trillion cubic feet of natural gas) the problem of future availability is then attacked. The indicated levels of potential production are startlingly high. Netschert concludes that in 1975, or thereabouts, domestic availability at no appreciable increase in constant dollar costs could be about 6 billion barrels of crude oil and 22.5 trillion cubic feet of natural gas per year without resort to imports or synthetic equivalents. (Production in 1956 was 2.6 billion barrels of crude oil and 10.9 trillion cubic feet of natural gas.) Actual production will depend on demand, import policy, and other factors, including the intersubstitution of different types of energy. These are to be considered in a larger investigation of the United States energy position that is in preparation and of which this study will be one part.

JAMES J. PARSONS

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African Economic Development, by WILLIAM A. HANCE. xi and 307 pp.; maps, tables, index, bibliogr. Harper and Brothers, New York, 1958. $4.95. $8\frac{1}{2} \times 5\frac{1}{2}$ inches.

Tropical Africa is too elephantine to be squeezed between the covers of a 300-page book. Professor Hance has wisely taken a magnifying glass to parts of its ancient hide.

In 35 pages, he brilliantly sums up Madagascar and puts new emphasis on its relation to the African continent compared with the traditional ethnic association with Asia. American financial dealings with Liberia are examined critically. The survey of transport in tropical Africa is the best available. Professor Hance ranges accurately and perceptively from race influence on economics in Rhodesia to Gezira cotton and Volta River Power.

The Council on Foreign Relations organized the distinguished seminar from which the book grew and has made another notable contribution to our foreign understanding.

The book is recommended as a basis for a course on tropical Africa or as part of a world survey of underdeveloped countries.

EDWIN S. MUNGER

American Universities Field Staff

Die Mongolei: Land, Volk und Wirtschaft der Mongolischen Volksrepublik, by ERICH THIEL. Vol. XIII of the Veröffentlichungen des Osteuropa-Institutes München, edited by HANS KOCH. 495 pp.; maps, ills., diagrs., appendix, bibliogr. Isar Verlag, München, 1958. DM 44.—. 9 x 6 inches.

Outer Mongolia or the Mongolian Peoples Republic, which is the subject of this book, is an area considerably neglected by American scholars. Until the appearance in 1956 of the ambitious *Mongolian Handbook* of the Human Relations Area Files (which is intended primarily as a compilation rather than as new research), English language studies of Outer Mongolia were largely limited to some scattered journal articles, some larger geological and paleontological studies, a very few books about the Mongols (rather than about Mongolia per se), and occasional traveller's-type or impressionistic accounts. Such a situation is not surprising when one considers that to do thorough scholarly work on Mongolia, especially beyond the scope of a journal article, it is necessary to have varying combinations of language skills; Russian is essential, and Chinese and Mongol only slightly less so, plus of course German, and knowledge of Japanese makes available the considerable material on Mongolia in that language. Particularly from a geographical point of view, field experience in Mongolia is a further necessary element, and for many years this has not been easy to come by; since the second world war, access to Mongolia by Americans has been nearly impossible. A tiny handful of Anglo-American scholars, perhaps no more than six or seven, is equipped to deal seriously with Mongolia. The problem is made more difficult in a sense by the fact that until very recently there were almost no studies by Mongols, except for some fragmentary historical materials, although in the last decade Mongols have begun to add to the published store of knowledge about their country.

These considerations make the present book especially valuable, for it makes extensive use of Russian sources and is also based in part on the author's field work in Mongolia, though he does not tell us when nor what it involved. Dr. Thiel is Professor of Economic Geography at the University of Munich, and an authority of long standing on northeast Asia. His *Verkehrs-Geographie von Russich-Asien* appeared in 1934, and his *Sowjet Fernost* in 1953, the latter published in English as *The Soviet Far East* in 1957; he is also the author of an unpublished two-volume study, *Wirtschaftskunde der Mandschurei*. *Die Mongolei* deals only with the Mongolian Peoples Republic (M.P.R.), and is essentially a recent and contemporary survey which follows closely the prescription of the book's subtitle. Like his *Sowjet Fernost*, *Die Mongolei* is organized in the conventional pattern established by long usage especially in German and Russian geographic literature. It is not an exciting book, and is mainly limited to a careful descriptive compilation of the basic facts about the physical and economic geography of Outer Mongolia. It is comparable to the HRAF *Mongolian Handbook* (also based largely on Russian sources, but curiously not listed in Thiel's extensive bibliography) but is not as wide in its scope.

Heavy dependence on Russian sources, as is necessary and proper, has resulted in the welcome service of presenting in summary form some of the fruits of the extensive Russian research on Outer Mongolia, especially since 1925 but also in the latter years of the Czarist empire. Although unquestionably the great bulk of published research on Mongolia has been done in Russian (and to some extent in German), Professor Thiel seems to have given insufficient attention to what studies exist in English and French, and particularly to have slighted the growing journal literature. For example, there is no reference to the work of Herold Wiens on the Mongolian range, despite a considerable section in *Die Mongolei* on livestock numbers, capacity of the grazing lands, and fodder problems. Professor Thiel may certainly be excused for not having used any Chinese or Japanese sources (although these were drawn on by the HRAF *Handbook*), and his bibliography does list the critical compilation of Chinese, Japanese, and Russian sources made by Chang Chih-yi (*A Bibliography of Books and Articles on Mongolia*, JRCAS, London, 1950), but it would have been appropriate to indicate the wealth especially of Chinese material which he was unable to consult.

The German approach is evident in the selection and organization of data, a brief outline of

which will indicate much about the book's nature: A. THE NATURAL FOUNDATION. General survey, historical geology and geomorphology, climate, hydrography, glaciation, landscape zones, soils, vegetation, fauna. B. POPULATION AND STATE. Historical development of the state, administration, ethnic composition, numbers and distribution, mode of life, health and population growth rates, culture, political and social conditions. C. THE ECONOMY. Animal husbandry (the longest single section in the book), agriculture, management of the agrarian economy, use of natural vegetation, hunting and fishing, manufacturing, trade, transport, finance. D. REGIONS AND TOWNS. There is no attempt at a general conclusion. A short appendix includes the Constitution of the M.P.R., a bibliography of 317 items, predominantly Russian works (but without any annotation), and a glossary. The lack of an index, except for geographical names, is irritating and really inexcusable. Presumably the author and publisher expect the reader to depend on the detailed table of contents with its neatly subdivided headings, and the equally neatly compartmentalized text. Such an arrangement hardly takes the place of an index, and tends to underline the essentially cataloging, compiling, handbook nature of the book.

Such a function has its obvious value, but most readers will regret that Professor Thiel has not made more of an attempt to interpret, analyze, fit together, generalize, criticize, or explain the mass of information which he presents, or to set it into a wider context. He has picked out in detail a great many trees but given few glimpses of the whole forest or of its meaning. Descriptive physical geography, historical geology, biogeography, and landscape classification occupy over half of the book, and these matters are the subject of most of the simple line-drawing maps. How regrettable it is that we must increasingly depend on others, including German and Russian geographers, to provide this kind of factual regional description. It is perhaps more unfortunate that Professor Thiel follows a similar descriptive pattern in dealing with the Mongol economy. His book yields few insights, despite the brief periodic "überblicks" provided for most sections of the book, almost perfunctory in nature as if they were a required part of a set formula whose central purpose was the cataloging of information.

A brief introduction includes a sketch of the history of the M.P.R. and of its situation relative to its neighbors, Russia and China. The historical-political theme is pursued in somewhat greater detail in Section B on Population and State, but seems clearly intended as background rather than as part of the book's particular contribution. Although political matters are appropriately given minor emphasis, in the light of the book's purpose, Professor Thiel's somewhat open-ended statements on the political status of the M.P.R. do not give an adequately clear picture of the strength of Russian influence in all fields, especially in economic planning. For example, the long and detailed sections on animal husbandry and agriculture fail to come fully to grips with the problem of collectivization, a matter which cannot properly be slighted in any discussion of the Mongol economy. No one would welcome cold-war polemics, nor does this reviewer by any means suggest that scholarly studies, especially in economic geography, should view their materials from any political vantage point. But Professor Thiel's subject can be divorced from its political context only with some sacrifice of intelligibility and usefulness, especially if the Russian impact on Outer Mongolia is given as little integrated attention as in the present book. Collectivization is referred to briefly in the short historical account of the M.P.R., but is never fully discussed. The short section on "management of the agrarian economy" outlines the private and public sectors of production, but in a predominantly matter-of-fact informational manner which almost sublimely passes over the prolonged and still undecided struggle over management.

It is true that Professor Thiel has written a physical and economic geography and does not claim even by implication to have produced a thorough regional analysis, despite the book's subtitle. This is unfortunately a common model in Russian geographic studies also. But when a specific large region, especially a national state, is the subject or setting for any major geographic study, the geographer should be obliged to consider that region in its totality and to consider, though he need not treat exhaustively, all factors of regional relevance—historical, political, cultural and other—as they may and almost certainly do affect the particular matters which he chooses to investigate. It is not enough simply to provide a descriptive summary of a check list sort. Data should be compiled not as ends in themselves but as the material from which fuller understanding is built. Professor Thiel's flat, prosaic style of writing, in a familiar guidebook genre especially in the economic sections, is appropriate to what he has done here, but perhaps not to what he ought to have done.

The 29 photographs, presumably taken by the author since no credits are given, are mainly excellent and make a reasonable sample of Mongol landscapes, people, and culture, but the pictures are nowhere listed and are provided with only the most general captions. Against the many complaints raised must be set however the value of the book. Professor Thiel has produced what is probably the most useful geographic survey of Mongolia to date outside of Russian and Chinese sources, drawing on materials and experiences open to very few American scholars. Whatever its limitations are felt to be, and even if it is not a compelling model for American

geographers, it is at least a book to which many of them must be indebted.

RHOADS MURPHEY

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Malaya, by NORTON GINSBURG and CHESTER F. ROBERTS, JR. xiv and 533 pp.; maps, index, bibliogr. University of Washington Press, Seattle, 1951. $6.00. 8¾ x 5¾ inches.

This lithographed volume is an admirable example of inter-disciplinary collaboration between a geographer and a political scientist. Its inception lay in a research project originally performed in 1955–1956 under contract to the Human Relations Area Files, Incorporated, by a group of social scientists at the University of Chicago. On the first page of their preface the authors describe their volume as "a kind of bench mark, an attempt to provide a descriptive and analytical basis for understanding a new Malaya about to embark on an unpredictable course of independence." "Analytical" is an important word here, for it is this quality which prevents the book from being a mere gazeteer. Facts and figures are presented in plenty but never gratuitously. Each plays its part in the authors' attempt "to examine the new Malaya in light of the systems of organization that have characterized the old" (p. v). But neither does the book pretend to be an encyclopaedia. To quote from the preface again: "The phases emphasized are those which in the authors' view are most significant in understanding the nature and potentials of what is clearly destined to be an increasingly important element in Southeast Asia's regional structure."

In this connection it must be noted that the term "Malaya" as used in this book includes both the recently constituted elective monarchy of Malaya and the British Crown Colony of Singapore, even though these are now two distinct units and, by all political portents, likely to remain so for some time to come. This expedient is a necessary recognition of the fact that since the forties of the last century Singapore has functioned as the primary city for the Malay States, a role which it sustains today despite a succession of attempts to develop Port Swettenham and improve Penang.

The book begins with a short discussion of the physical environment, notable, I believe, as containing the first general account of Malayan climate to draw on the prescient work of Dr. I. E. M. Watts. Next follows a 30-page outline of such history as is necessary to enable the reader to comprehend the intricately interlaced strands of current life, but here the authors have been led astray by the utterances of false prophets. The misconceptions of this chapter are of small importance in the development of the book's major theme, and would scarcely merit mention here were it not that the excellence of the rest of the work will render it liable to indiscriminate use as a convenient summary of Malayan history. Space forbids my itemizing errors of fact in this section but I feel constrained to comment on a few points. In the first place, since the publication of the researches of J. C. Van Leur (*Eenige beschouwingen betreffende den ouden Aziatischen handel*, Middelburg, 1934, and *Indonesian trade and society. Essays in Asian social and economic history*, 1955) and of F. D. K. Bosch (*Het vraagstuk van de Hindoe-kolonisatie van den Archipel*, Leiden, 1946, and "Local genius en oud-Javaanse kunst," *Mededeelingen der Koninklijke Nederlandsche Akademie van Wetenschappen* [new series, deel 15, pt. 1], Amsterdam, 1952), it is no longer possible to accept the account of Indian culture transference as given here (p. 18). Neither can it be maintained that Sailendran territorial expansion of the eighth century was in any way associated with the decline of *Fu-nan* (p. 20), which had fallen before *Chen-la* in about A.D. 550. Likewise the Cōḷa raid of c. 1025 could have had little effect on Tumasik which was not founded until near the end of the thirteenth century (*loc. cit.*).

I believe, too, that, the first of the factors contributing to the growth of Malacca (as listed on p. 24) can stand elaboration. The full significance of Malacca's strategic position is apparent only when we remember that the port was situated on the crucial sector of the world's major trade route, which had one terminus in Venice and the other in the Molucca Islands. In both the Archipelago and the Indian Ocean spices traveled by many routes, but to the Strait of Malacca there was no practicable alternative. Here the staple produce of the Archipelago was funneled through a natural channel, the only point throughout the 8000 miles of the trade route where a monopoly of spice distribution could be effectively established. Tomé Pires put his finger on the crux of this matter in his famous phrase: ". . . quem for sõr De malaqa tem a mãao na garganta a veneza" (*Suma Oriental*, folio 178 recto). Incidentally, Malacca, although situated at the narrowest part of the Strait, was not at the strategically critical point. This was the Klang district, where sailing routes approached closest to the Peninsular coast in order to avoid the Capacia Shoals (Sulaimān b. Aḥmad al-Mahrī in *MS. 2559* of the Bibliothèque Nationale in Paris, folio 88 verso, 1.6—folio 90 verso, 1.2; and *Wu-pei-chih*, chap. 240, folio 16 verso). While on this topic, it should be noted that the supposed successor to Parameswara who became a convert to Islam (p. 25) was in fact Parameswara himself under his new Muslim name.

This introductory material is followed by chapters on demography, settlement, and trans-

port and communications, each a model study of its kind. Chapter 6, too, is a beautifully executed analysis of the nature of communication in this plural society, a condition which presents unusually complex problems not only as between the four major communities but also as between special, and even specific, communities within them. As a logical development of this discussion, the authors then examine the social and economic characteristics of Malay, Chinese, and Indian Society. Later chapters analyze both the plural economy of Malaya, which is distinguished by a strong ethnic specialization tending to the isolation of its Malay sector, and also the political development which culminated in the achievement of independence on August 31, 1957. The book concludes with a short recapitulation which gathers up the threads of the several discussions and casts a glance towards the future.

A comprehensive 15-page bibliography, based on the Human Relations Area Files, Incorporated, indicates the authors' intimate acquaintance with the technical literature relating to Malaya. To their impressive list of titles I would add only the following. First, I would list the two standard works on Malayan history, namely, Dato Sir Roland Braddell's magistral series of papers which laid the foundation of our present knowledge of the early period ("An introduction to the study of ancient times in the Malay Peninsula and the Straits of Malacca," appearing over a period of 20 years in the *Journal of the Malayan Branch of the Royal Asiatic Society*), and Lennox A. Mills's "A history of British Malaya, 1824–1867," in the same journal for 1925. This, although written more than 30 years ago, is still the best account of nineteenth-century Malaya. Professor Dobby's paper on the Kĕlantan delta in the *Geographical Review* for 1951 has also escaped mention, though this author's other works are generously acknowledged in both text and bibliography. But most of all I regret the omission of any mention of the numerous scholarly contributions of Dr. C. A. Gibson-Hill, who has done so much to illumine our knowledge of Malayan ethnology and history.

The several sections of the book are illustrated with a series of maps, sometimes conceptually ingenious and always cartographically satisfying. On the frontispiece, though, the city of Bangkok is erroneously represented by the symbol for cities of less than 500,000. It would be captious to cavil at the district, rather than the mukim, basis of the distribution and concentration maps, but the additional labor involved in the latter method would undoubtedly have sieved out certain conclusions which have escaped the coarse mesh of district analysis. Recent work undertaken on this basis in the University of Malaya, for example, has elicited some hitherto elusive quantitative information on the immigration of Malays into Malaya from both Siam and Indonesia.

The text is remarkably free from slips and misprints, but in the event of a second edition the following might be corrected: p. 10, note 7, for 1056 read 1956; pp. 157 and 161, the College of Medicine in Singapore was named after King Edward VII, not King George; p. 162, English has never been the *primary* language of instruction in the Nan Yang University; kĕrĕbau is a better transcription than that on p. 197; p. 229, for *bomor* read *bomoh*.

This volume will inevitably invite comparison with the recently published report for the International Bank for Reconstruction and Development (*The Economic Development of Malaya*, Baltimore, 1955), but nearly always to the latter's disadvantage. The new state of Malaya is indeed fortunate to have an accurate, sympathetic, and penetrating statement of its cultural and economic resources to hand at the outset of its policy making. It is to be hoped that the book will circulate widely through the Secretariat at Kuala Lumpur.

PAUL WHEATLEY

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Agriculture in Natal 1860–1950 (Vol. 12 of *Natal Regional Survey*), by N. HURWITZ. viii and 123 pp.; maps, charts, tables. Oxford University Press, New York, 1957. $4.20. $8\frac{1}{2}$ x $5\frac{1}{2}$ inches.

Agriculture in Natal: Recent Developments. (a symposium) (Vol. 13 of *Natal Regional Survey*). x and 205 pp.; illus., maps, diagrs., tables. Oxford University Press, New York. (Not yet published in U. S. A.) $7.20. $8\frac{1}{2}$ x $5\frac{1}{2}$ inches.

The Natal Regional Survey arose from an enthusiasm for planning and regional survey that infected South Africa, in common with many countries, at the end of the war. The initiative came from the Social and Economic Planning Council of South Africa, which sought to encourage regional surveys in all parts of the Union. Only the Natal Survey came to fruition, and that it did so, and has survived persistent shortages of staff and finance, is due mainly to the energy of H. R. Burrows, Professor of Economics in Durban, who directed the work until his retirement in 1957.

This small research and publishing organization has now put out 20 volumes, including special reports, and has a further ten in hand. These constitute a substantial body of published work on the land, work, and people of this complex corner of Africa. Several of the volumes, outstandingly Vol. 1 (*Archaeology and Natural Resources*, A symposium), Vol. 3 (*The Distribu-*

tion of Population in Natal by T. J. D. Fair), and the present two are of interest to geographers.

Professor Burrows has had to take authors as he found them, and there is, unfortunately, much overlap and great variation in quality. Population and European agriculture each receives two volumes, the Indian community gets three, and several touch on various aspects of Native life. Some volumes are very superficial; others have extremely close local detail and great depth. Outstanding in this respect is the large *Durban Housing Survey* (Additional Report No. 2), which is possibly the most impressive single volume.

The two volumes here reviewed exemplify both the strengths and the weaknesses of the whole series. In conception they were clearly intended to be complementary: Dr. Hurwitz presents an economist's history of European agriculture, and this is followed by a volume written by a number of specialists, mainly from the University of Natal's Agricultural School, who present a picture of the agriculture of the Province at the present day. Most of the specialists also present historical material, and since Dr. Hurwitz presents his history under the heading of each enterprise, large and small, there is substantial overlap. Dr. Hurwitz also deals with some current problems that are adequately treated in the symposium. One feels that a single volume, in which Dr. Hurwitz might have provided a substantial historical introduction, could have met the case better.

Dr. Hurwitz is known to readers of this journal through his work in co-operation with Professor K. M. Buchanan, and it comes as a surprise to find that this co-operative work is nowhere referred to in the present book. There is a large number of dot-distribution maps, and some attempt is made to relate distributions to environment, but this is not pursued far. Many other promising lines receive tantalizingly sketchy treatment, even the discussion of rural credit which is the book's most original contribution. A brief mention of von Thünen is the sole excursion into location theory in a section entitled "The development of land use regions" (pp. 104–108).

The great symposium, on the other hand, is a mine of information of great value to geographers. There is a sound introductory treatment of the natural environment, picking out those aspects that are of significance, and this is followed by a series of concise, meaty chapters on each of the major agricultural enterprises, with environmental, technological, and economic aspects held well in balance. The book is illustrated by numerous well-chosen photographs, but maps are few; Dr. Hurwitz' valuable series of distribution maps could with advantage have been featured in the companion volume.

The picture of European agriculture that emerges is of extensive, labor-rich farming, diversified locally by more intensive cultivation, particularly in the coastal sugar belt and in the dairying and wattle-growing areas of the favored "mist belt" inland. Environment is by no means the sole factor, however: it is interesting, for example, to note that the highest milk yields are obtained not in the cooler uplands but in the immediate vicinity of subtropical Durban, where more intensive practices are adopted. Arable land in the "Garden Province" is limited by the vigorous relief, and there are great problems arising from the long dry season, from frost incidence, from violent rains, and from friable and easily erodible soils. Low yields are a widespread problem.

These volumes, more particularly the symposium, deserve a place in any collection devoted to the agricultural geography of subhumid or economically "new" lands. It is to be regretted that their high price will limit their market, but this regret applies to the series as a whole.

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